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MET O 11 TECHNICAL NOTE NO. 159

The Blizzard of April 1981.

by

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1. INTRODUCTION

In the period 24-26 April 1981, large areas of the country were affected by substantial falls of rain, sleet or snow. It was felt that this situation would be suitable for investigating the performance of the new Fine Mesh forecast model, and comparing it with output from the current operational model (Rectangle). It was also felt that further investigation of the optimum grid length for the new Fine Mesh model was required, interest centring on improvements in forecasts as the grid length was reduced from 150 km to 75 km or 50 km. The Rectangle output used in the investigation was normal operational output. That for the new Fine Mesh was based on the appropriate ECMWF data set interpolated down to the varying grid lengths. The forecast was then run using a version of the Fine Mesh model suitable for the ECMWF Cray computer (the Cyber 205 not being available at the time of this investigation).

2. SYNOPTIC DEVELOPMENTS

a. Upper Air Features At 500 mb 00Z on 24 April 1981 a fairly sharp trough extended from Scotland just North of West to almost 30W, (Fig. 1). The flow over virtually all UK and the near continent was 290-310 degrees. During the next twelve hours, the Eastern portion of this trough swung quickly South; by 12Z on 24th, an almost complete circulation was evident over SE Scotland with a marked trough to the SW. (The remaining portion of the trough lay almost E/W along 55N). The flow had backed to 250-270 over England/Continent, veering 360-030 over N. Ireland and Scotland. At this stage, the trough phased in with a surface low which became very active over UK.

The cold Northerly extended South into Biscay by 12Z on 25th, the centre moving slowly SSE with a very sharp trough almost N/S at 5W (Fig. 2/3). As the centre transferred slowly SE into N. France, the flow over France backed considerably, gradients increasing appreciably. The direction of flow became aligned with the trailing surface cold front, a situation favouring the development of waves on the front. This lead to a new surface development which greatly delayed the clearance of the precipitation from SE UK.

b. Surface Features At 12Z 23 April 1981, an area of low pressure, associated with a triple point, lay to the West of Ireland. Pressure was high over Iceland, with another surface anticyclone at 47N 25W. The UK lay in a very slack field. By 00Z 24th, the low was over Galway Bay and was deepening slowly. (Fig. 4) With no upper circulation at this stage, it was expected to move steadily SE in the upper NW'ly flow.

The centre moved ESE at 25 kts but by 0600, it was slowing down and showing signs of turning left, the largest pressure falls being over N. Wales. During the next few hours, the centre phased in with the upper trough which was swinging south. The surface centre then turned NE over Anglesey, went south of the Isle of Man and finally turned south by 18Z on 24th, completing a loop. By this time, the speed of movement was down to 12kts, the central pressure 995 mb; the associated fronts had swung right across the country into SE England an occlusion lying through the E. Midlands, NW to N. Wales. The occlusion process had produced substantial falls of precipitation, much of it snow, particularly to the North of the surface low.

The low then turned East of South, crossing the extreme western tip of S. Wales, then Devon, ending up as a filling centre Northwest of the Channel Isles by 12Z on 25th, central pressure 999 mb, (Fig. 5/6). The trailing cold front of the system extended roughly from Dover to Bordeaux, with small ripples running up it. One such ripple developed a small circulation W of Boulogne (12Z on 25th) and although this centre did not deepen significantly, there was a definite transfer of activity away from the old centre to this new one. During the next 18-24 hours, this small centre swung WNW, then W up the Thames Estuary, then SW crossing the coast near Portsmouth and finally SSE away into France, travelling at about 10 kts.

The fronts of the system became somewhat ill-defined but some form of the old occlusion persisted - or at least some convergence zone between the very cold NE'ly flow and the moister, milder ESE'ly flow - moving slowly south into southern England. As the secondary low over SE England re-activated the old occlusion/convergence zone, the area of significant precipitation developed North-westwards again producing another period of snow in many parts and prolonging the original precipitation in others by another 12-24 hrs.

3. MODEL PERFORMANCE

a. 500 mb Patterns There appears to be little difference in the forecast fields for T + 24 in broad terms. However, there are some slight differences between the models in the shape of the trough, the Rectangle having a sharper trough with the strongest flow already ahead of the trough axis. The New Model kept a more rounded shape to the trough with the strongest flow in the base of the trough; this rounded shape more closely models the actual situation. (See Fig. 7-9). By T + 36, the Rectangle forecast had taken the centre over Cherbourg, the flow ahead of the trough being veered somewhat from reality. The New Model kept the centre further West than the Rectangle but still not as far back as it should have been. The flow around the trough was not greatly better than the Rectangle being veered ahead of the trough in much the same way. (Fig. 7-10).

b. Surface Pressure Fields As described in section 2b. and as can be seen from Fig. 11 the main low centre performed a loop in the Irish Sea, finally decaying away SE in the Channel some 36 hrs later.

The operational Rectangle forecast showed a steady and fairly fast movement of a single low centre ESE across the south Wales coast and southern England ending up on the Belgian coast at 12Z on 25th (999 mb). This prediction was erroneous in track and speed of the system, implying a much faster clearance of the precipitation than in fact occurred. It would seem that the model correctly shifted the development area eastwards but maintained one system rather than allowing the first to decay and then developing another small scale feature further east. In the matter of timing, the model was badly out.

The New Model with a grid length of 150 km showed a centre in the Irish Sea 12Z on 24th moving to near Exeter by 00Z on 25th. Although the track is somewhat fast, it is already better than the Rectangle product. Reduction of the grid length to the Fine Mesh of 75 km produced further considerable improvement. As can be seen from Fig. 12, the suggested track for this model gave quite an accurate representation of what actually occurred. After 24 hrs. the forecast position was near Swansea (998 mb), in very close agreement with the split centre over S. Wales. A further twelve hours took the centre somewhat too far south but nonetheless, for the whole period gave good advice.

A reduction of gridlength to 50 km produced a very similar evolution to the 75 km version, the timing being marginally more accurate but probably not sufficiently better in view of the extra computer time involved.

In addition to handling the evolution of the main low well, both versions of the new Fine Mesh (grid lengths 75 km and 50 km) predicted a new development just west of Boulogne at 12Z on 25th, again quite an accurate representation of reality.

c. Precipitation During the period 00Z to 18Z on 24th a good deal of snow fell over the NE Midlands, NE England, the Borders, central and southern Scotland. Most precipitation over southern England was rain.

For comparison purposes it was necessary to use twelve hour periods 06-18 and 18-06, the actual rainfall amounts being taken from the synoptic data bank. Some detail over the high ground is therefore lost due to lack of observations but a certain amount of extra information was gleaned from the 24 hr accumulations of rainfall reporting stations for the period 09Z/24th to 09Z/25th.

In the period 06-18 on 24th, peak falls of over 20 mm occurred in the Borders SE to N. Yorkshire with another secondary peak (over 15 mm) in the Midlands, (Fig. 13). These areas associate well with the occlusion process and the triple point itself. The Rectangle produced a single peak area over the E. Midlands, amounts over 15 mm: this may be taken as agreeing quite well with the reported peak in the Midlands. However, virtually no precipitation was forecast for the Border area or any of southern Scotland (2 mm), this whole area being greatly in error, (Fig. 14).

The New Model (grid length 150 km) did predict a little more rain over S. Scotland, with about 5 mm in the Borders and Dumfries. Amounts elsewhere were poor, the peak area being over Somerset and Mid-Glamorgan (10 mm). The distribution of accumulation appeared to reflect the topography within the model rather than the synoptic situation, (Fig. 15).

With the Fine Mesh model, grid length 75 km, there was a transfer northwards of a peak area 15-20 mm to Liverpool Bay - amounts reported here were about 10-15 mm. Accumulations generally over NW England were quite reasonable.

However, this model again failed to predict the real peak area of precipitation in the Borders etc., predicting amounts of around 6 mm. Reduction of the grid length to 50 km produced the same distribution pattern with no improvements in accumulations, (Figs. 16/17).

During the next twelve hour period (18Z on 24th to 06Z on 25th), peak precipitation fell in a band almost E/W from Anglesey to Lincolnshire with another maximum over the Norfolk coast. Accumulations were 10-15 mm in the west and 15-20 mm in the east, (Fig. 18). The Rectangle made a reasonable attempt at this forecast with a peak of just over 20 mm in E. Anglia, a composite of the Lincs/Norfolk reported peaks. However, the Irish Sea/ E. Ireland area was badly under predicted, 2 mm c.f. 10-15 mm, (Fig. 19).

The New Model at 150 km grid length again held the main precipitation area over Wales with only 5 mm in eastern areas, generally a poor prediction, (Fig. 20). The Fine Mesh version, gridlength down to 75 km, produced realistic accumulations - around 20 mm maximum - but the peak area was over the Midlands with 6 mm over E. Anglia. Amounts in N. Wales/Cheshire were overpredicted though the Irish Sea and coasts were quite reasonable. The 50 km grid length Fine Mesh transferred one peak area into the E. Midlands with realistic accumulations but overdid amounts over most of Wales, (Figs. 21/22).

d. Humidity It was felt that the distribution of humidity at medium cloud levels was of most significance in this situation, most of the precipitation being of a dynamic rather than convective nature; hence the humidity mixing ratio at 750 mb was chosen for investigation.

At 00Z on 24th April, a ridge of quite moist air lay over UK. By 00Z on 25th, this moist air had largely been occluded out leaving a small area of moister air over the near continent with a moist tongue extending from the continent NE over the Wash to the Fylde coast. Drier air had dug in, behind the cold front, right across to SE England. By 12Z on 25th, the moist ridge or tongue had moved east into the southern North Sea (with little in the way of observational data); nonetheless, the pattern suggested was of a broad ridge including SE England and E. Anglia in the moister air, (Fig. 23).

The Rectangle analysis was in broad agreement with that hand drawn from actual T-Ø analysis; the Rectangle having the advantage of a background field arguably may have been more correct. By 00Z on 25th, the model had produced a

tongue of higher values with the same broad shape as the actual but the tongue was much broader. The area of HMR 2 gm/kg did not extend as far North as it should and covered much of Southern England and all of Wales, (Fig. 24). The dig of dry air was far less noticeable reaching only to Dorset with the driest zone over the Channel Isles rather than SE England. Hence, the distribution of moisture available for dynamic rainfall was incorrect, there being insufficient moisture far enough North to produce the quantities or rainfall recorded. By 12Z on 25th, there was still a narrow tongue of moister air extending almost E/W over Southern England, the dig of drier air having extended East into Kent and Northern France. This pattern is consistent with the transfer East of a low centre, as in the Rectangle version, but shows little evidence of a renewed push North over E. England and the N. Sea.

The New Model Fine Mesh forecast started from HMR fields which were too dry; this was found to be associated with a general error in transferring data from ECMWF format to that for running the New Model, since corrected. However despite the error in initial fields, the Fine Mesh forecast is very similar to the Rectangle forecast at 00Z on 25th. (See Fig. 25). There is a good representation of the tongue of higher HMR values though this tongue is again a little far South with slightly lower HMR values over S. Scotland than were actually reported. By 12Z on 25th, the moist tongue lay over Southern England - again much as the Rectangle - with somewhat lower HMR values over much of UK than were reported. Again there is little evidence of a renewed push North over E. England and the N. Sea.

It would seem likely that had the New Fine Mesh Model started from rather higher HMR values, even greater rainfall amounts would have been predicted but the general distribution of rainfall would not have been greatly different.

4. CONCLUSIONS

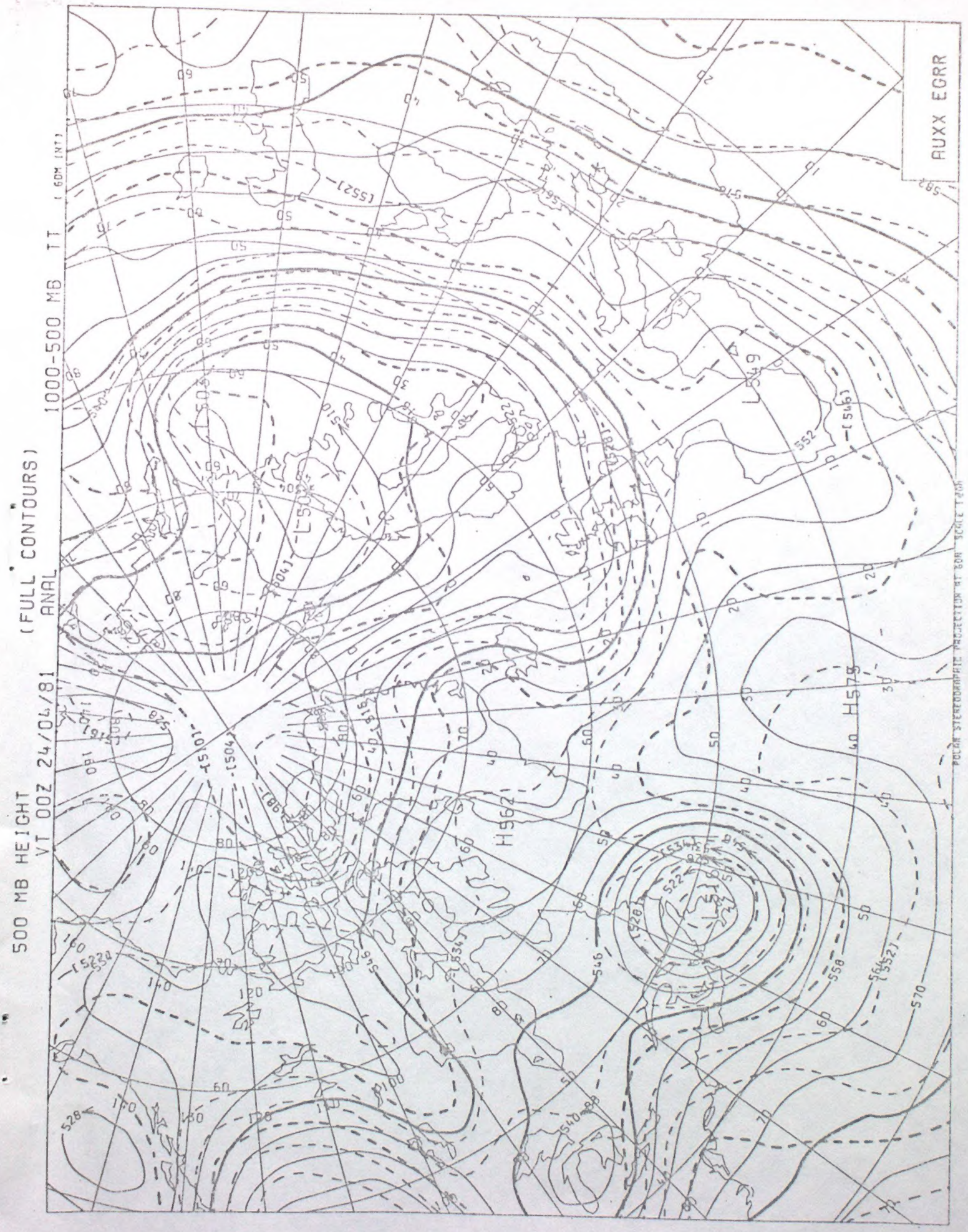
In comparing results from the New Fine Mesh Model with the operational Rectangle output, it should be borne in mind that the New Model was in early stages of development at the time these runs were made. Data were interpolated from ECMWF fields; topography over UK was not the final version, neither was land/sea designation.

Despite these limitations, an improvement in advice as to the movement and development of the low pressure system involved with this significant rain/snow fall was achieved using the New Model advice, over the Rectangle. However, although rainfall

amounts were improved to some extent, the actual distribution of rainfall was still lacking; there was a noticeable increase in amounts using a grid-length of 75 km rather than 150 km of the coarse Mesh but little further improvement was evident when the grid length was further reduced to 50 km.

It is hoped that some of the deficiences mentioned in this report will be remedied when the model is run on the Cyber computer from our own analysis, using improved topography and land/sea designation.

Fig.1 500mb Analysis, 00Z 24 April 1981. (Octagon)



.Fig.2 500mb Analysis, 00Z 25 April 1981. (Octagon)

Fig. 3 500mb Analysis, 12Z 25 April 1981. (Octagon)

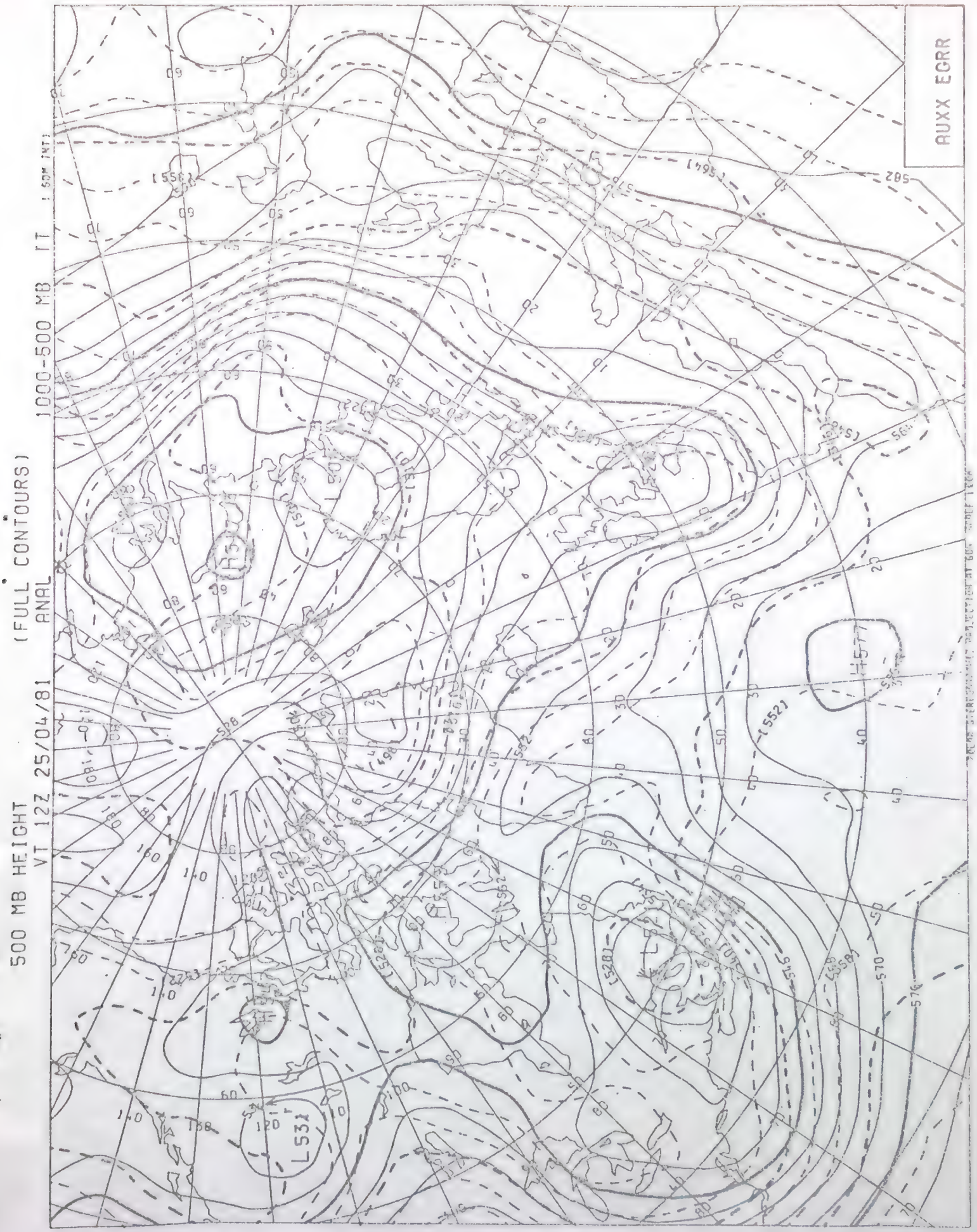


Fig. 4 UK Analysis 00Z 24 April 1981.

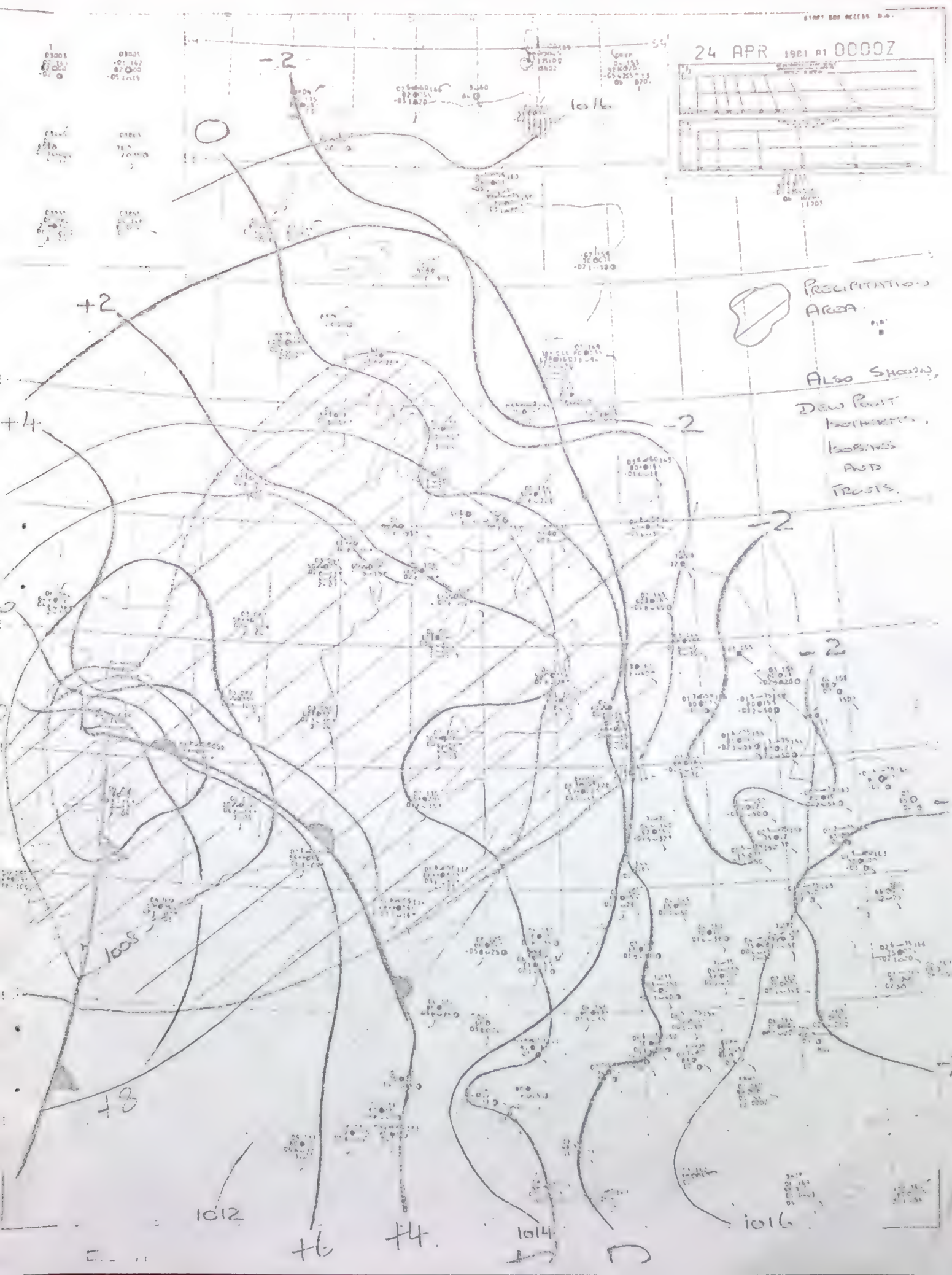


Fig. 5 UK Analysis 00Z 25 April 1981.

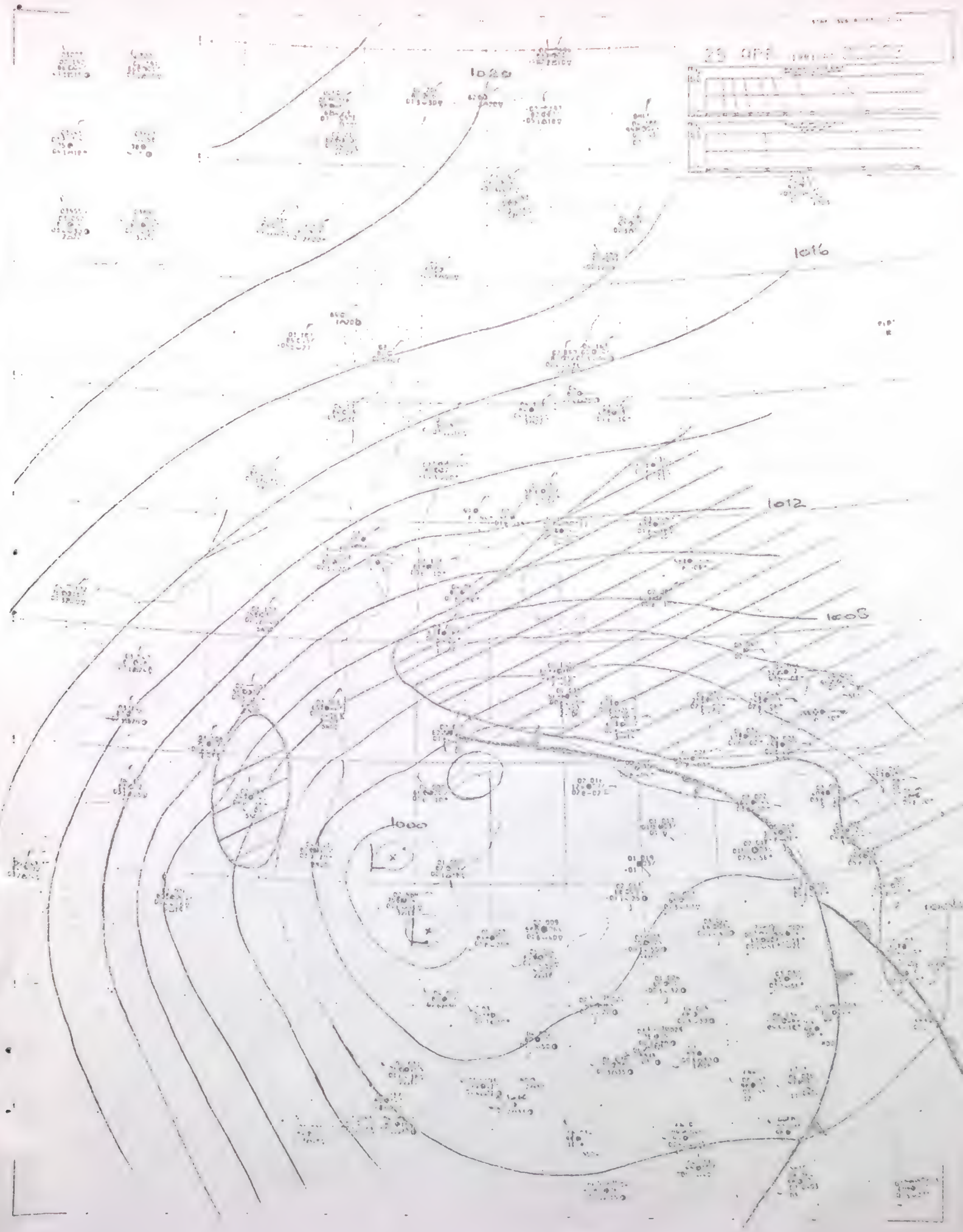
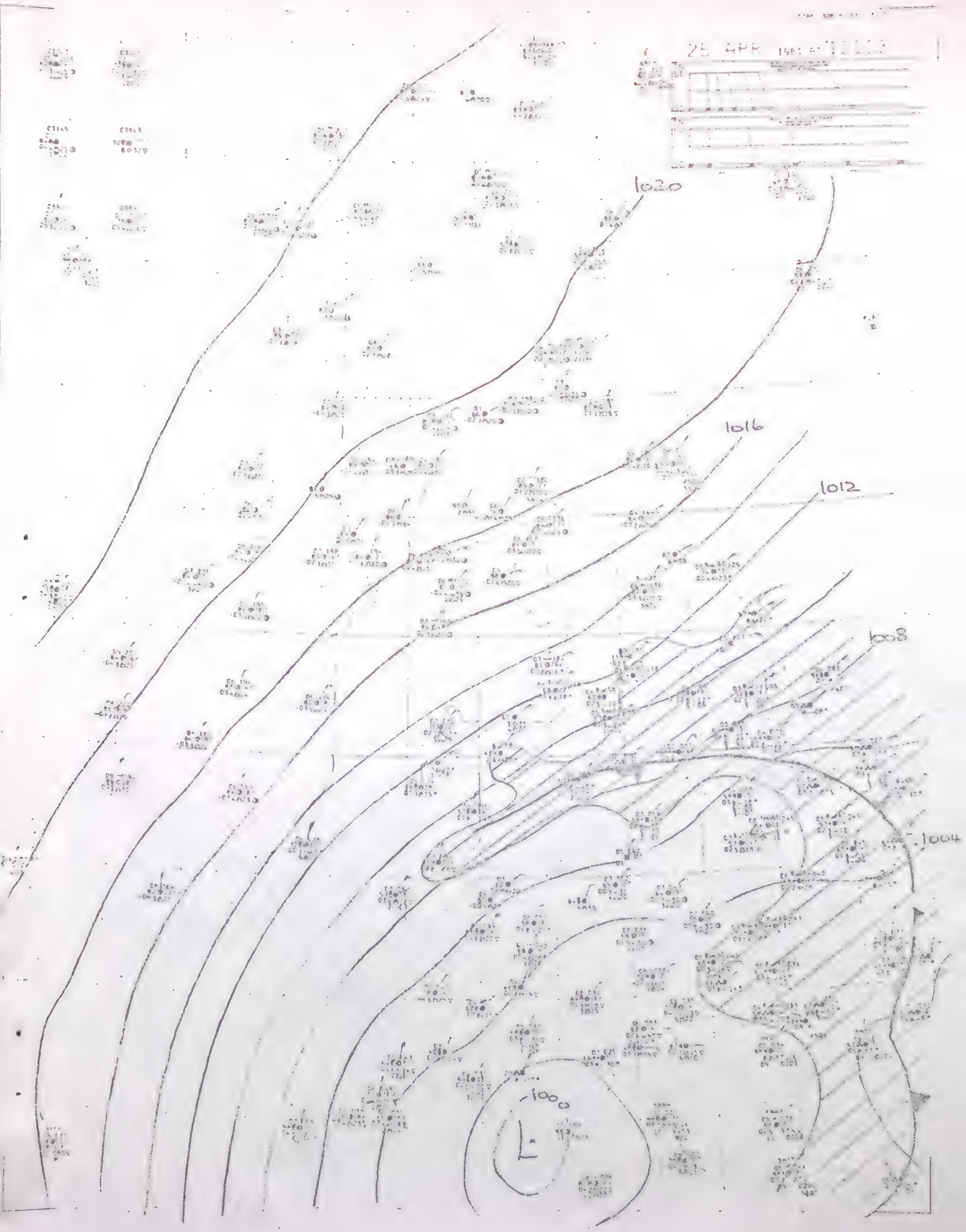
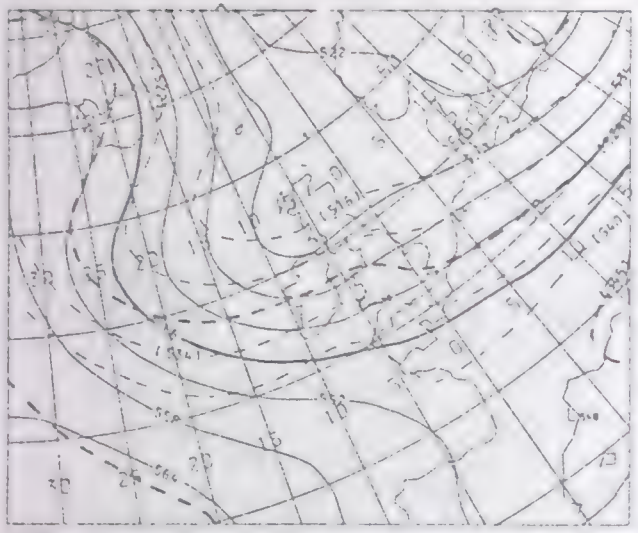


Fig. 6 UK Analysis 12Z 25 April 1981.



500 MB HT AND 1000-500 MB THICKNESS (PECKED). DM

6HR FORECAST VALID AT 6Z 24/4/81 DATA TIME 0Z 24/4/81



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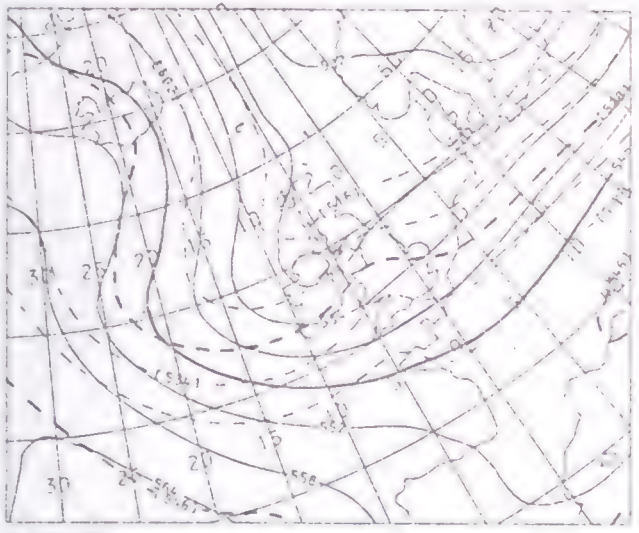

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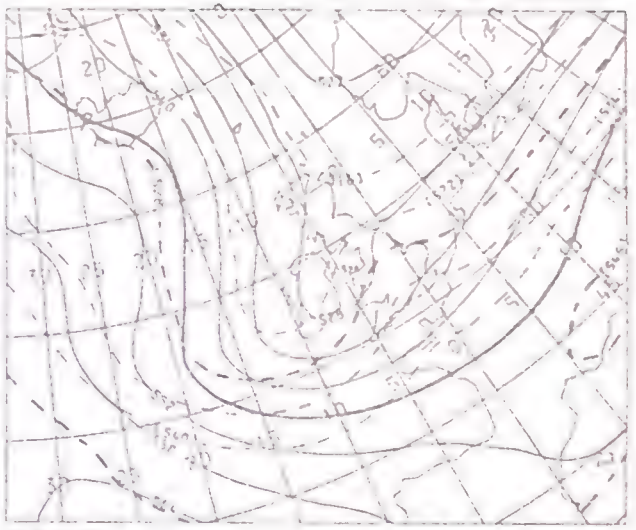

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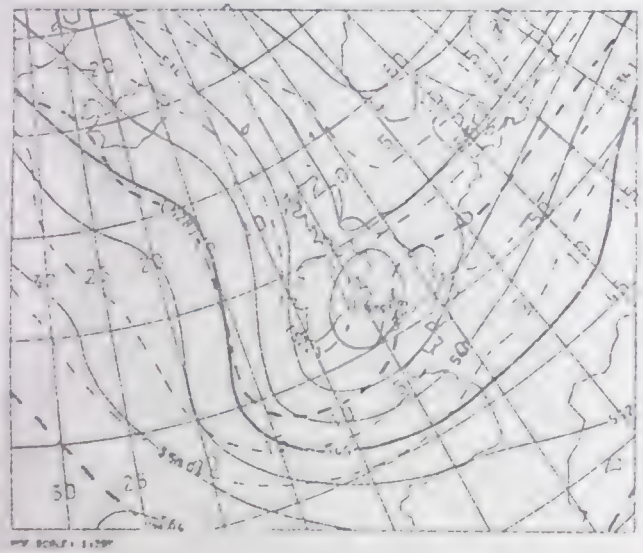

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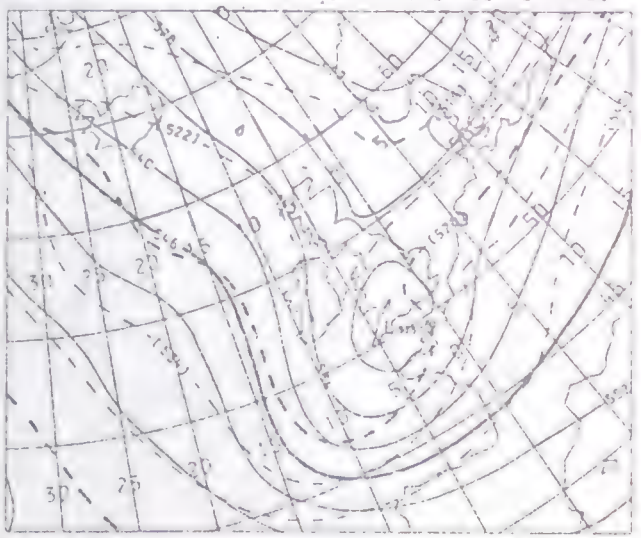

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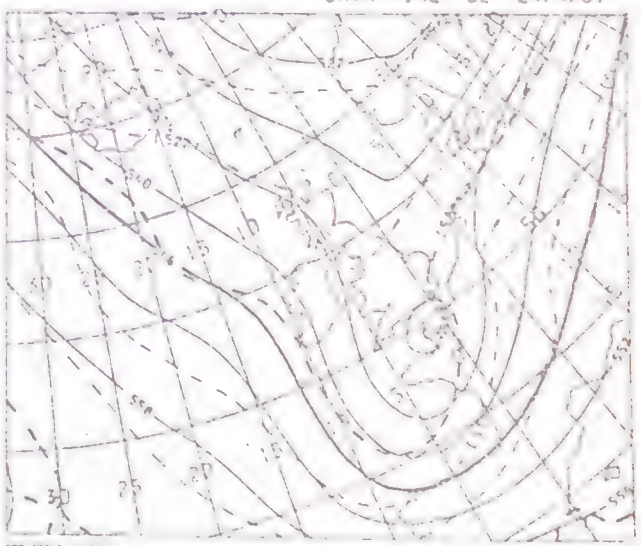
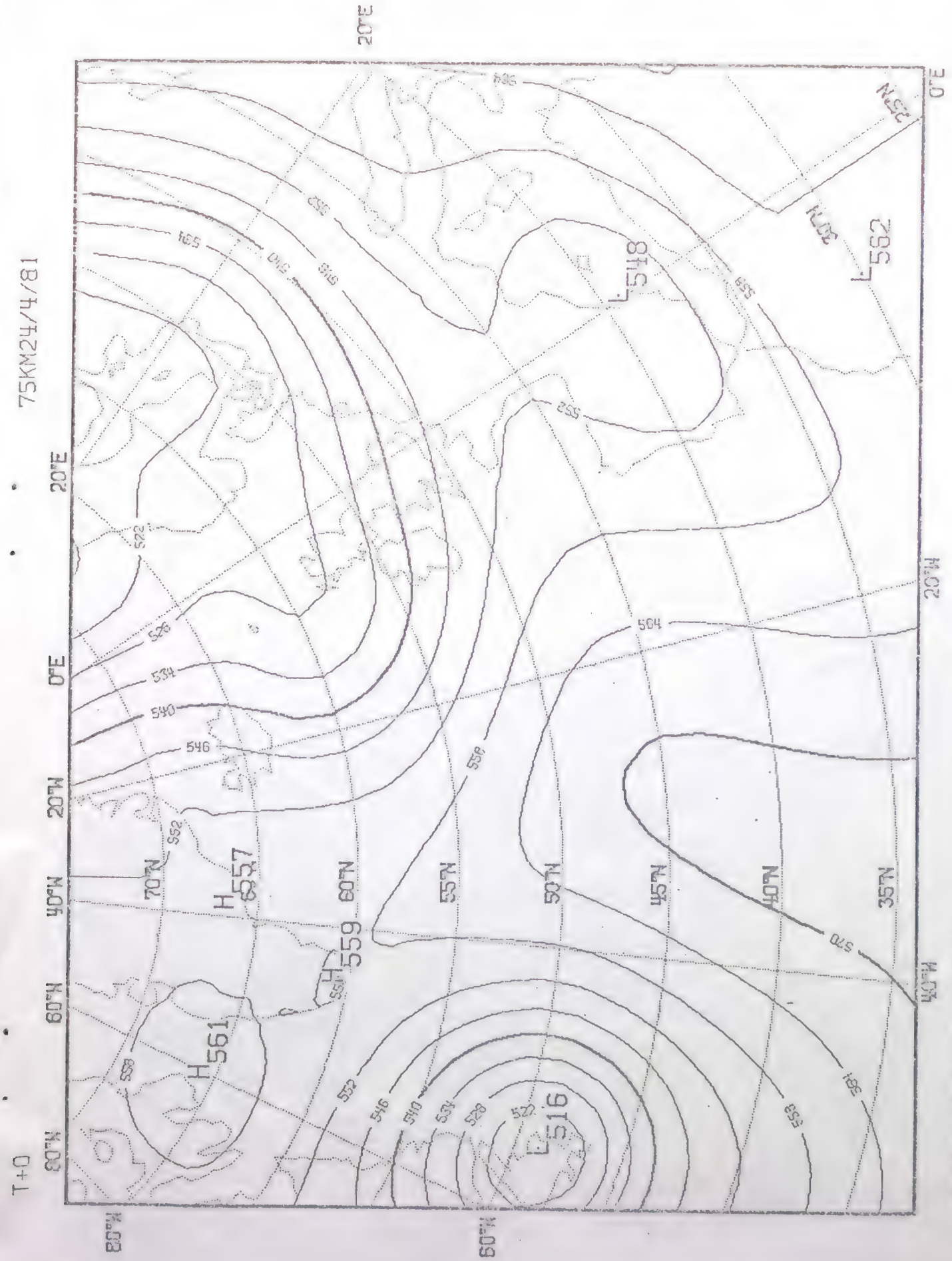


Fig. 7 Rectangle operational 500mb Forecasts.

Fig. 8 New Model Fine Mesh (75km Grid) 500mb Analysis 00Z 24 April 1981.



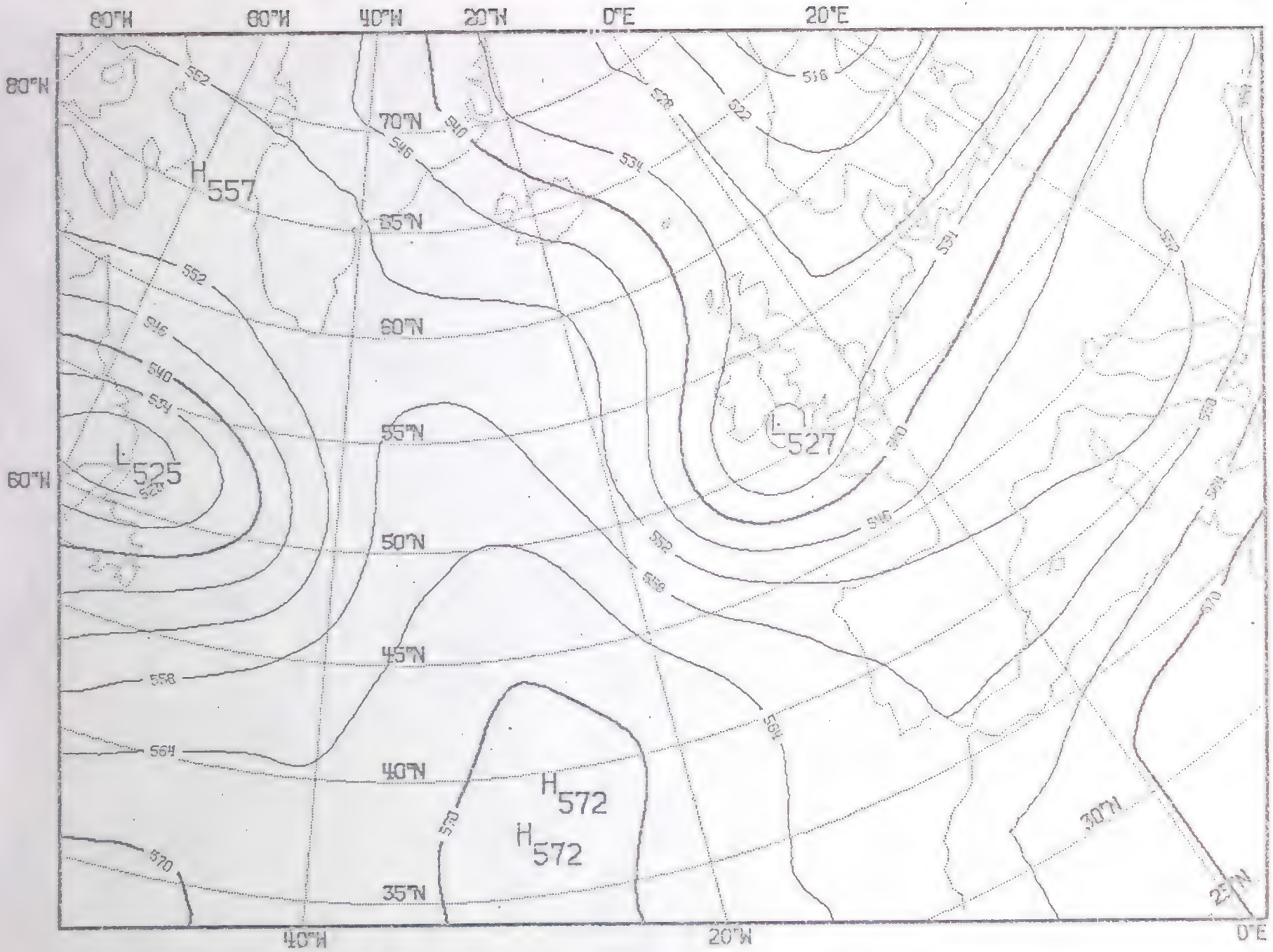


Fig. 9 Low Model Fine Mesh (75km grid) 500mb Forecast for 25 April 1981.

Fig. 10. New Model Fine Mesh (75km Grid) 500mb Forecast T+36 25 April 1981.

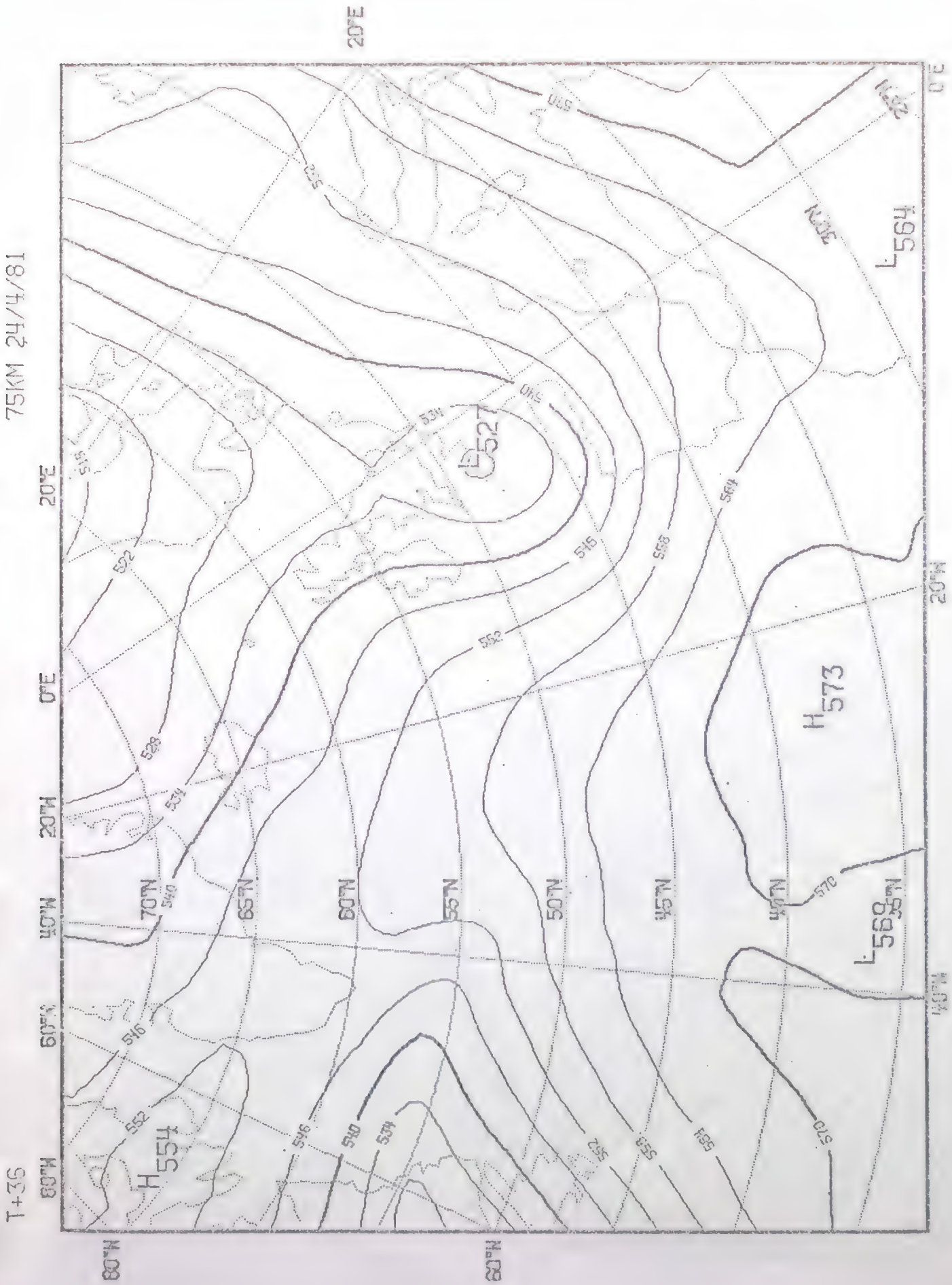
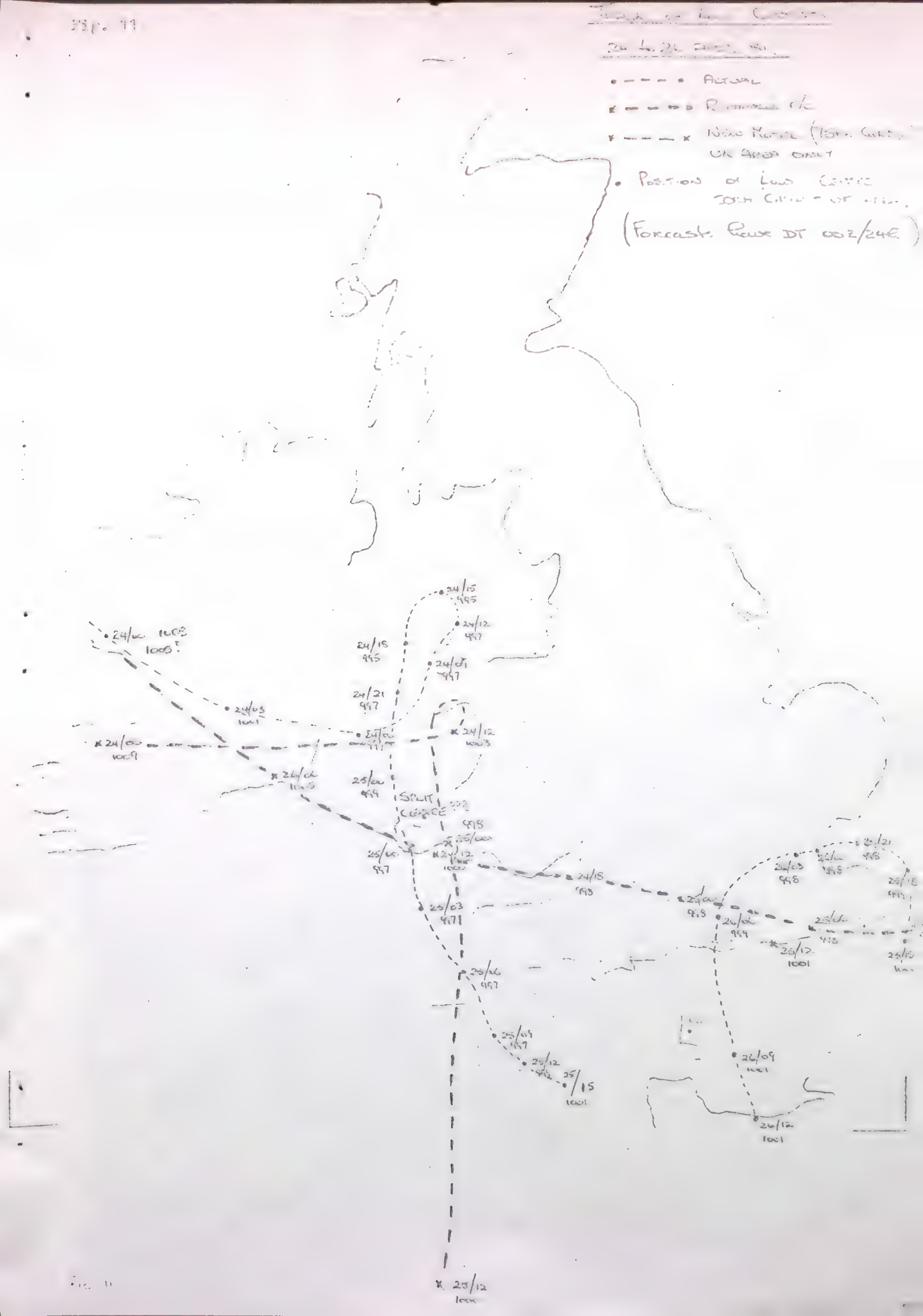


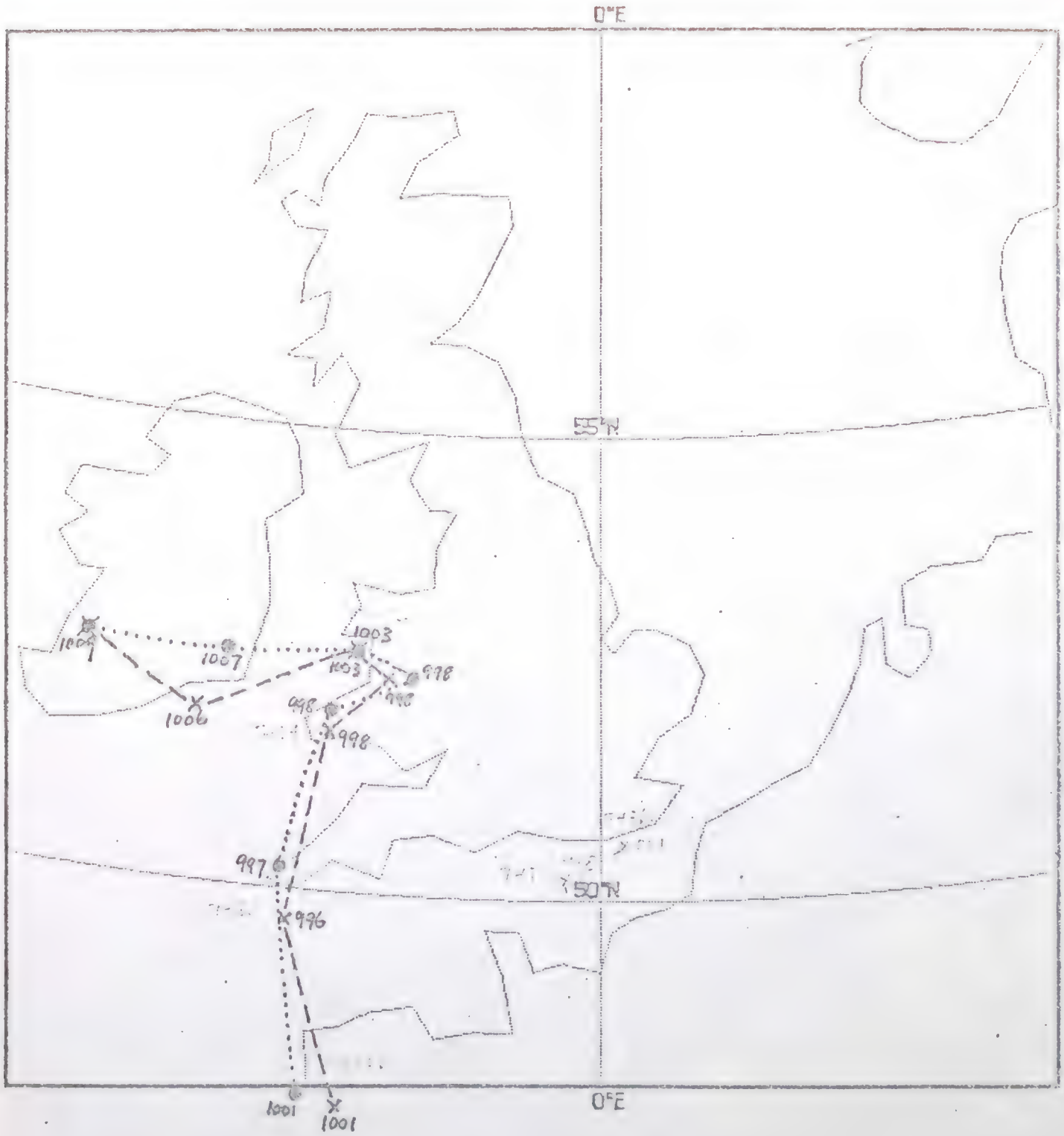
Fig. 11



Actual
Position of Low Centre
(Forecast Have DT 00Z/24E)
24/15
995
24/12
997
24/18
995
24/21
997
24/03
1001
24/00
1009
24/12
1003
25/00
999
SPLIT CENTRE
25/00
997
24/18
998
25/03
997
25/06
997
25/09
997
25/12
25/15
1001
26/09
1001
26/12
1001
25/12
1001

Fig. 11

Fig. 12



NEW MODEL DT 00Z 24/4/81

Movement of depression – positn plotted at 6-hr intervals T+0, 6, 12 36

●·····● 50 km gridlength version
X——X 75 km gridlength version

Fig. 13 ACTUAL Rainfall (mm) 0600Z 24 April'1981 - 1800Z 24 April 1981.

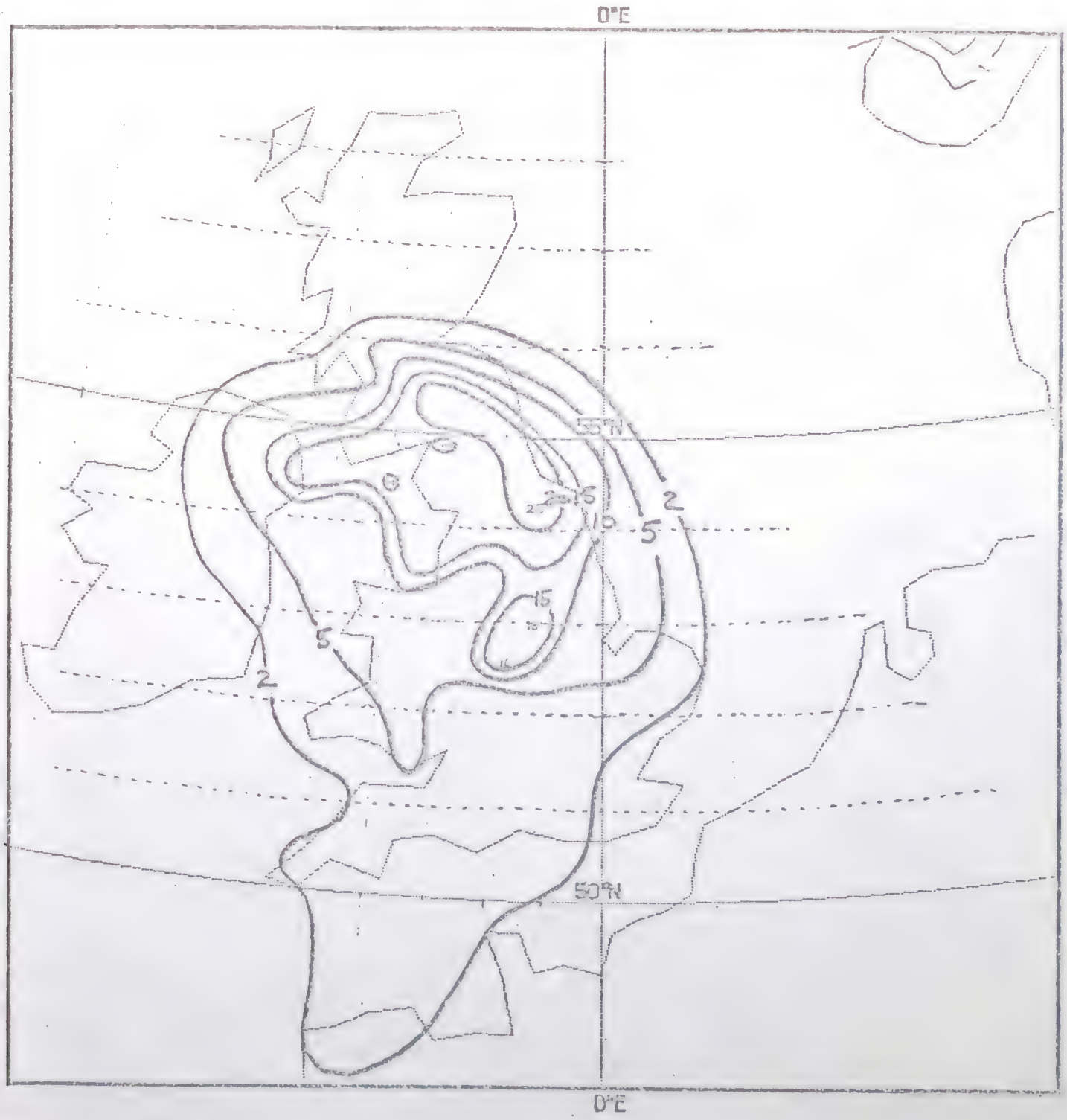


Fig. 14 Rectangle Forecast Accumulated Rainfall (mm) 0600Z 24 April 1981 to 1800Z 24 April 1981.

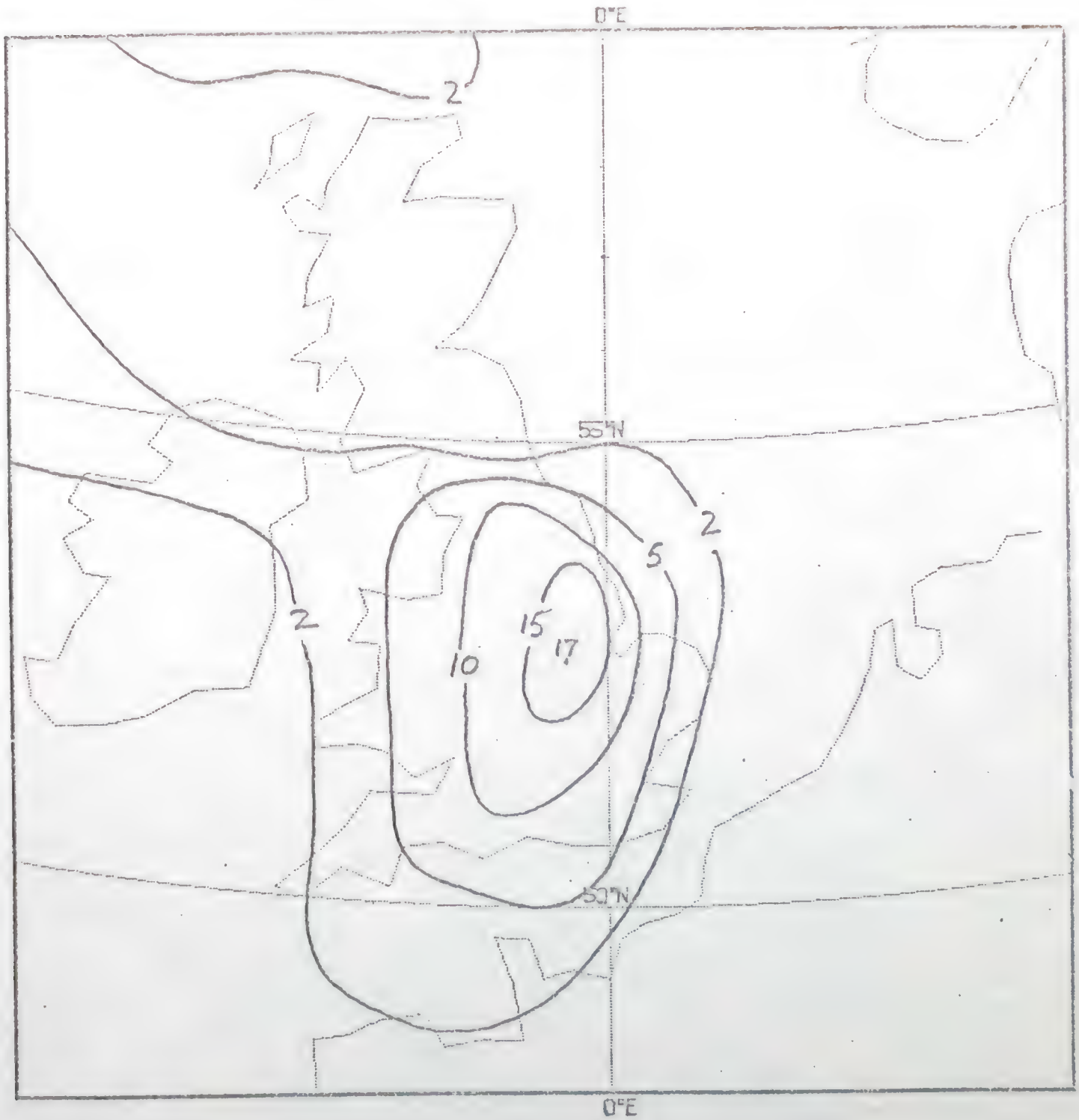


Fig. 15 New Model Coarse Mesh Forecast Accumulated Rainfall (mm) 0600Z 24 April 1981 to 1800Z 24 April 1981.

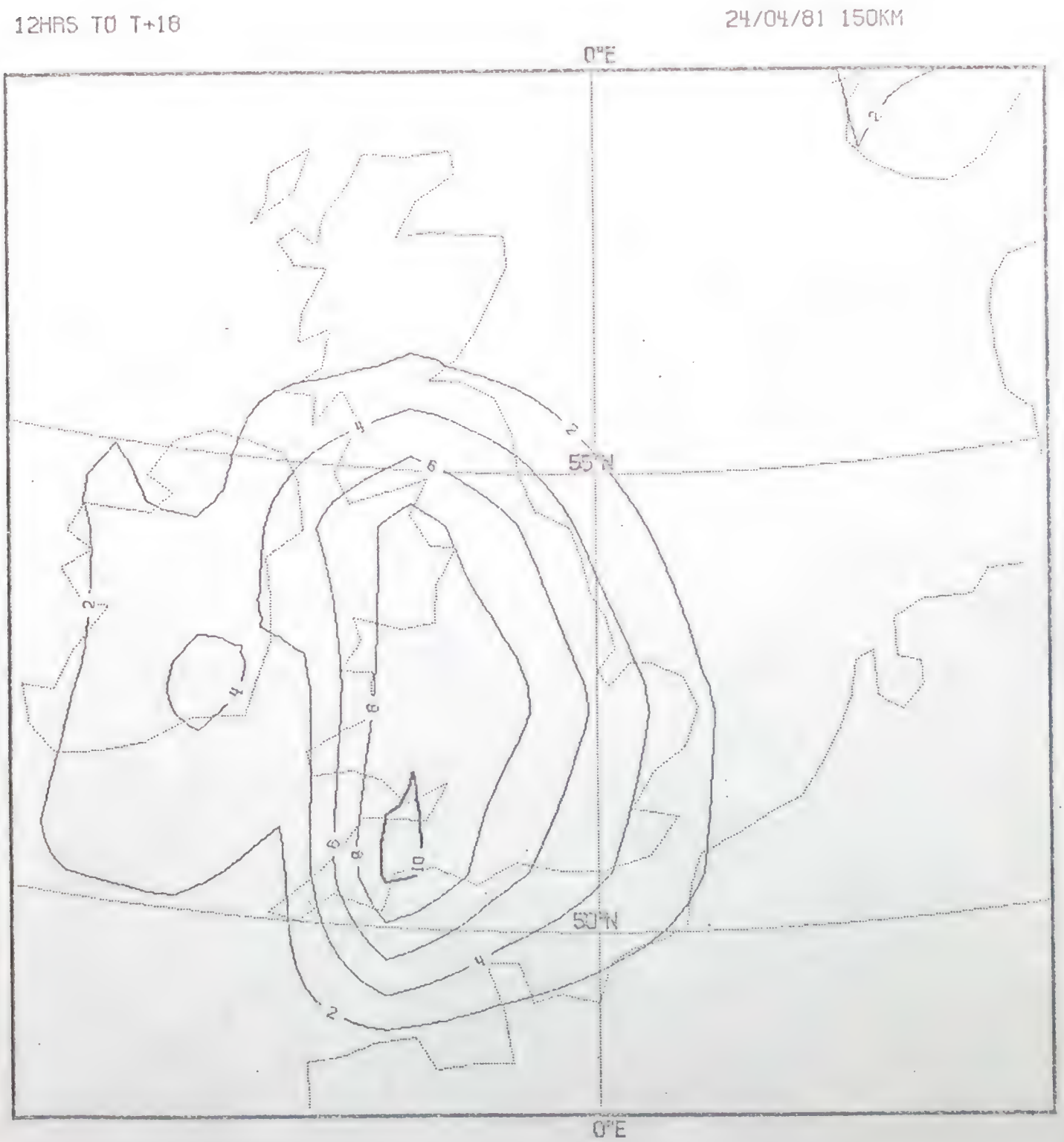


Fig. 16 New Model Fine Mesh (75km Grid) Forecast Accumulated Rainfall (mm)
0600Z 24 April 1981 to 1800Z 24 April 1981.

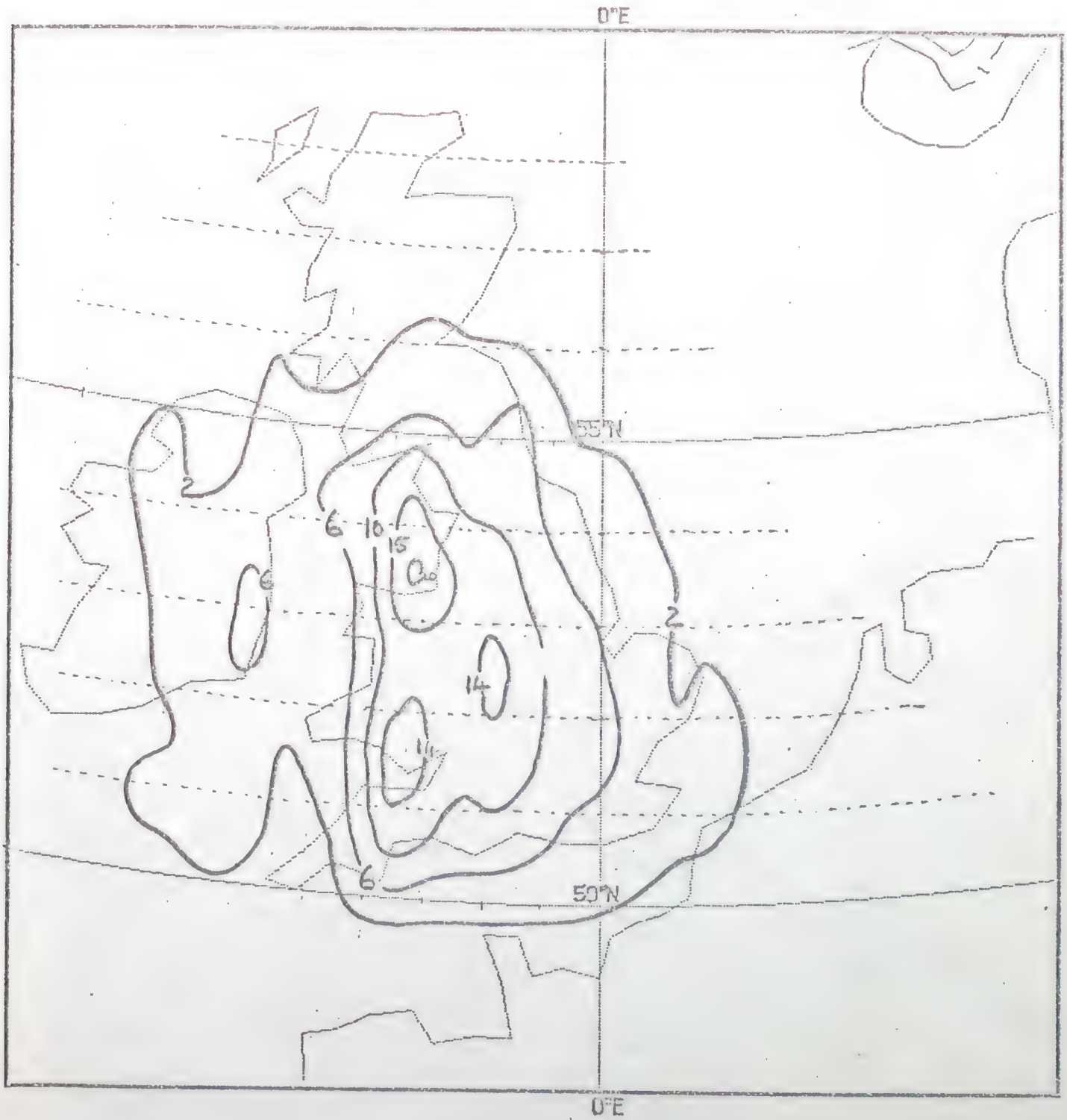


Fig. 17 New Model Fine Mesh (50km Grid) Forecast Accumulated Rainfall (mm)
0600Z 24 April 1981 to 1800Z 24 April 1981.

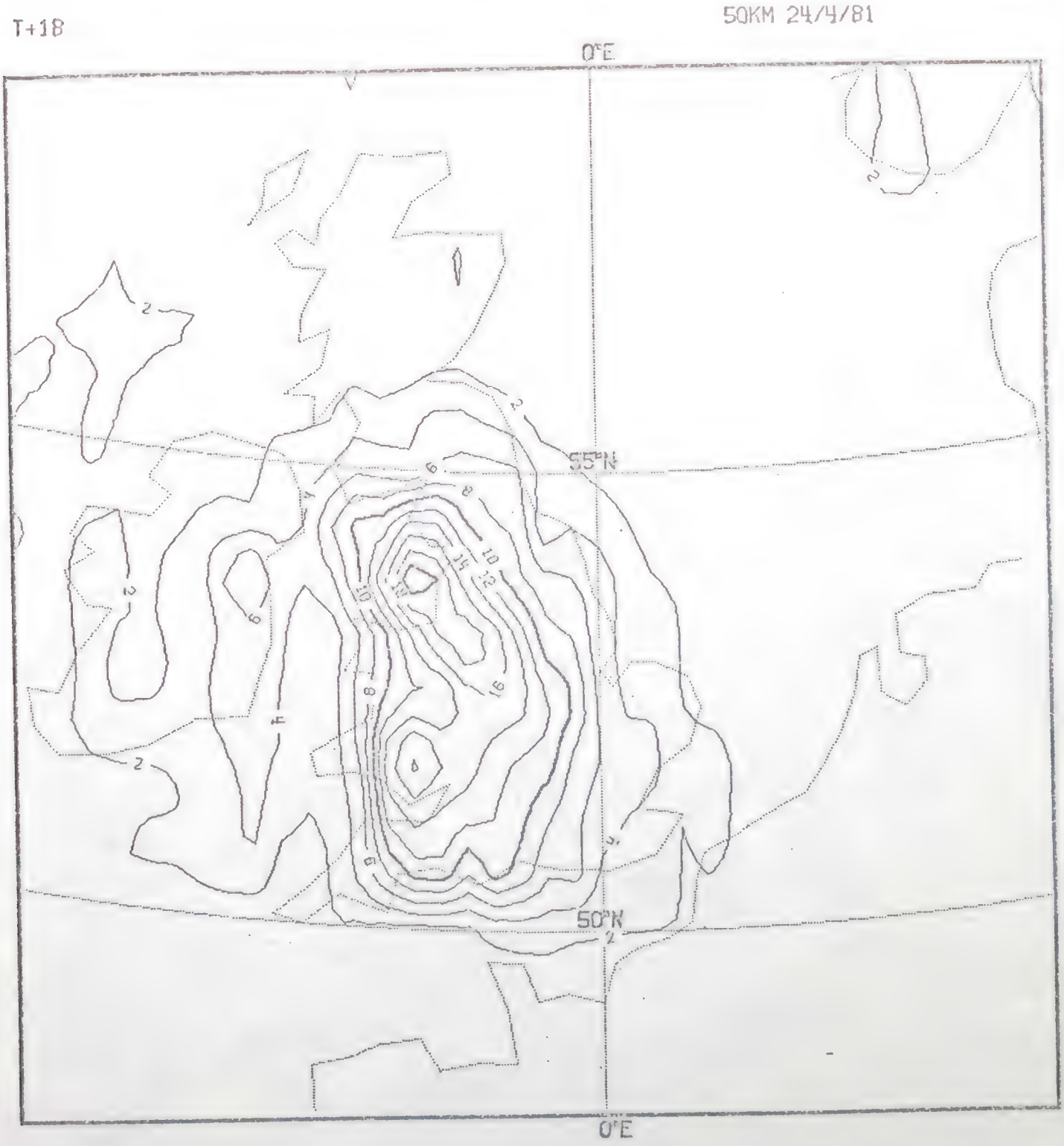


Fig. 18 ACTUAL Rainfall (mm) 1800Z 24 April 1981 to 0600Z 25 April 1981.

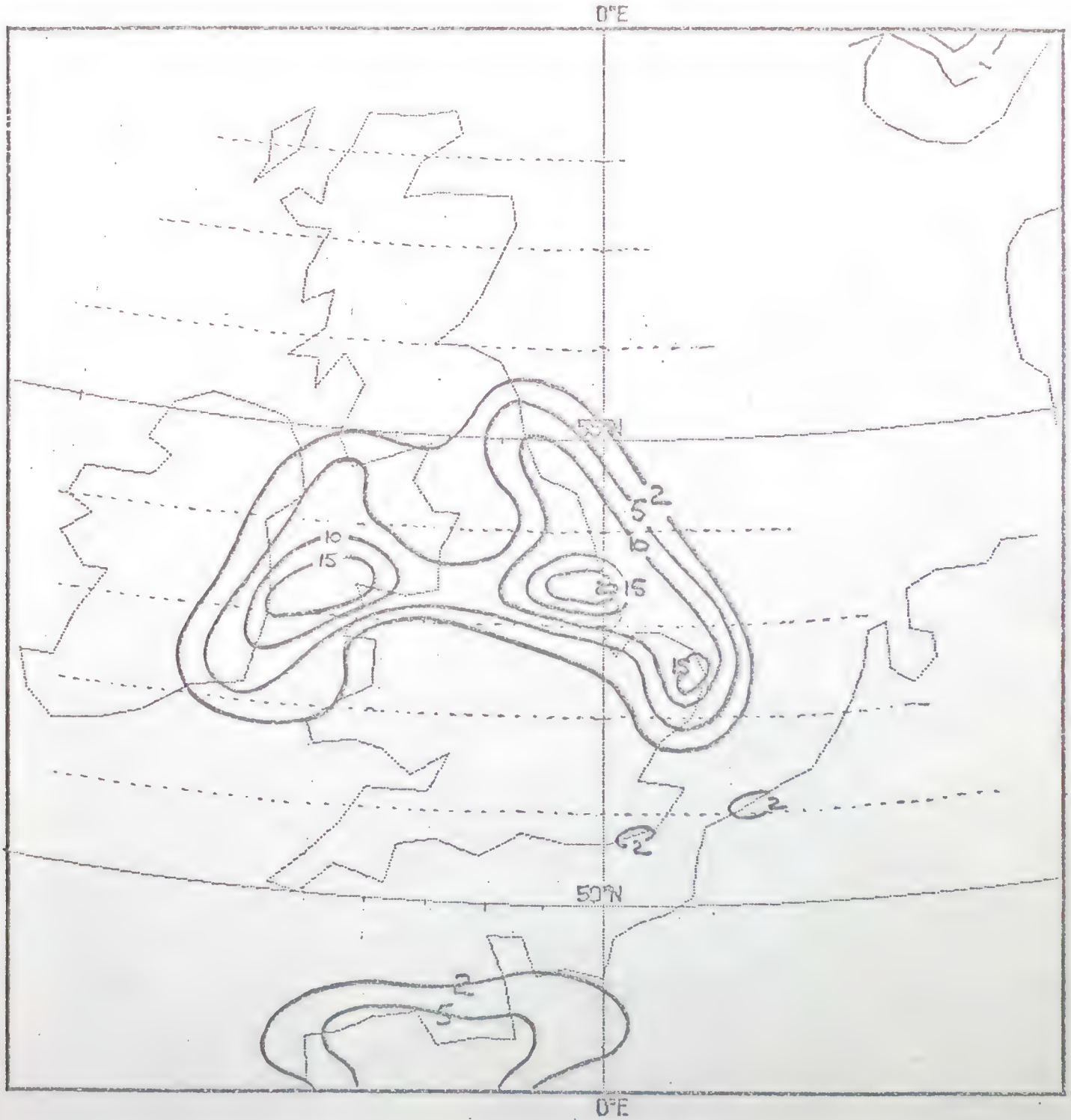


Fig. 19 Rectangle Forecast Accumulated Rainfall (mm) 1800Z 24 April 1981 to 0600Z 25 April 1981.

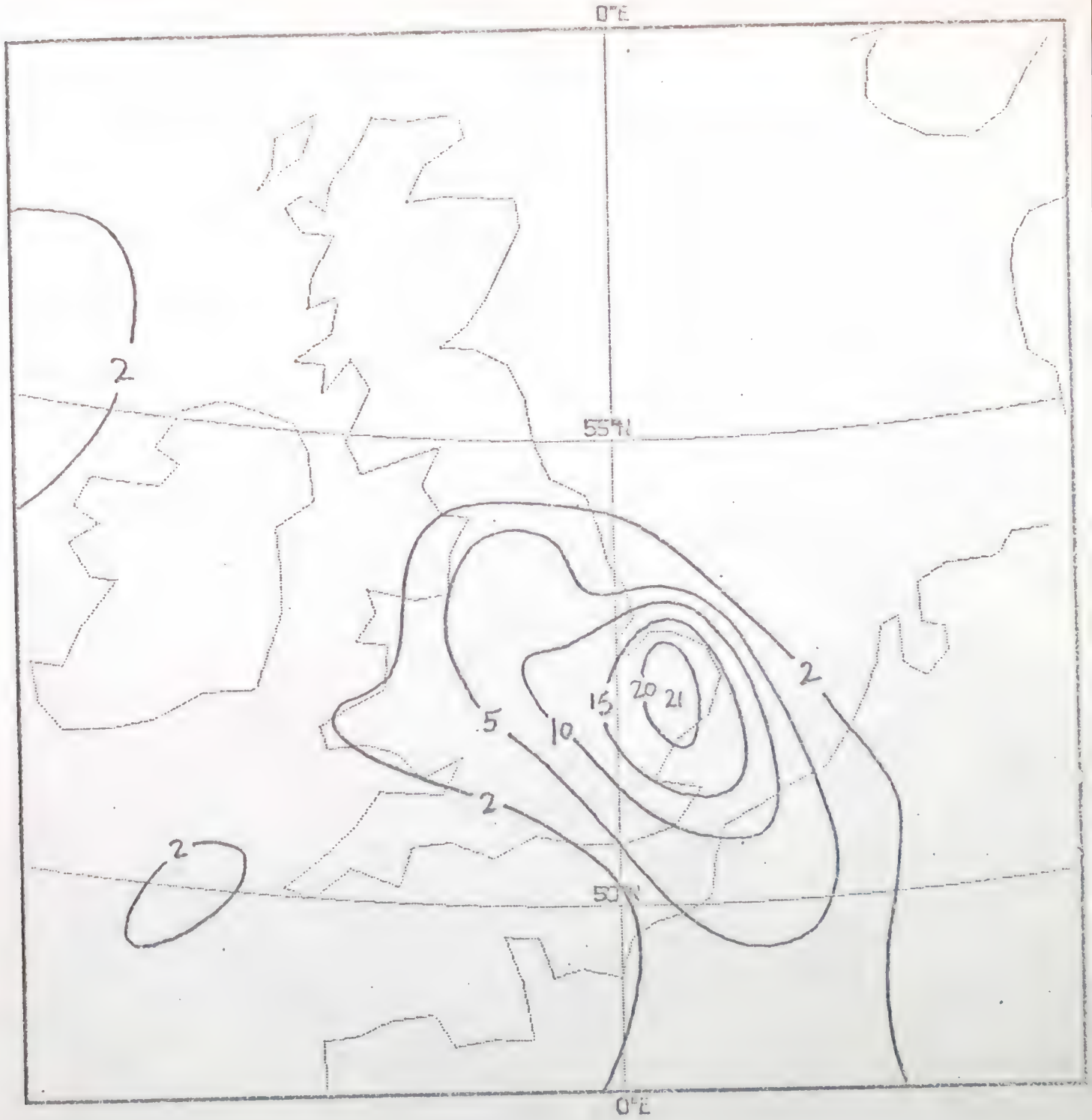


Fig. 20 New Model Coarse Mesh Forecast Accumulated Rainfall (mm)
1800Z 24 April 1981 to 0600Z 25 April 1981.

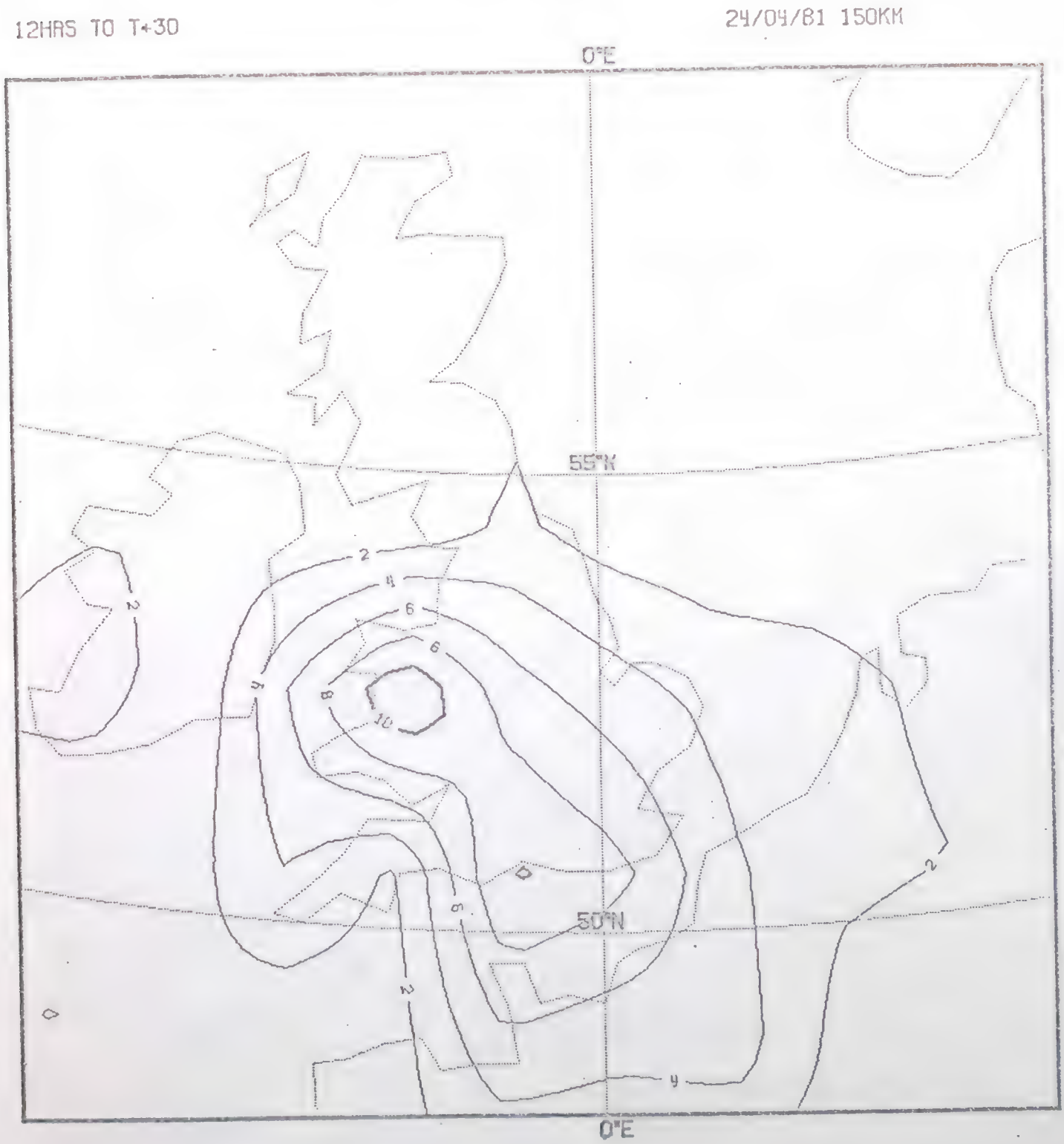


Fig. 21 New Model Fine Mesh (75km Grid) Forecast Accumulated Rainfall
1800Z 24 April 1981 to 0600Z 25 April 1981.

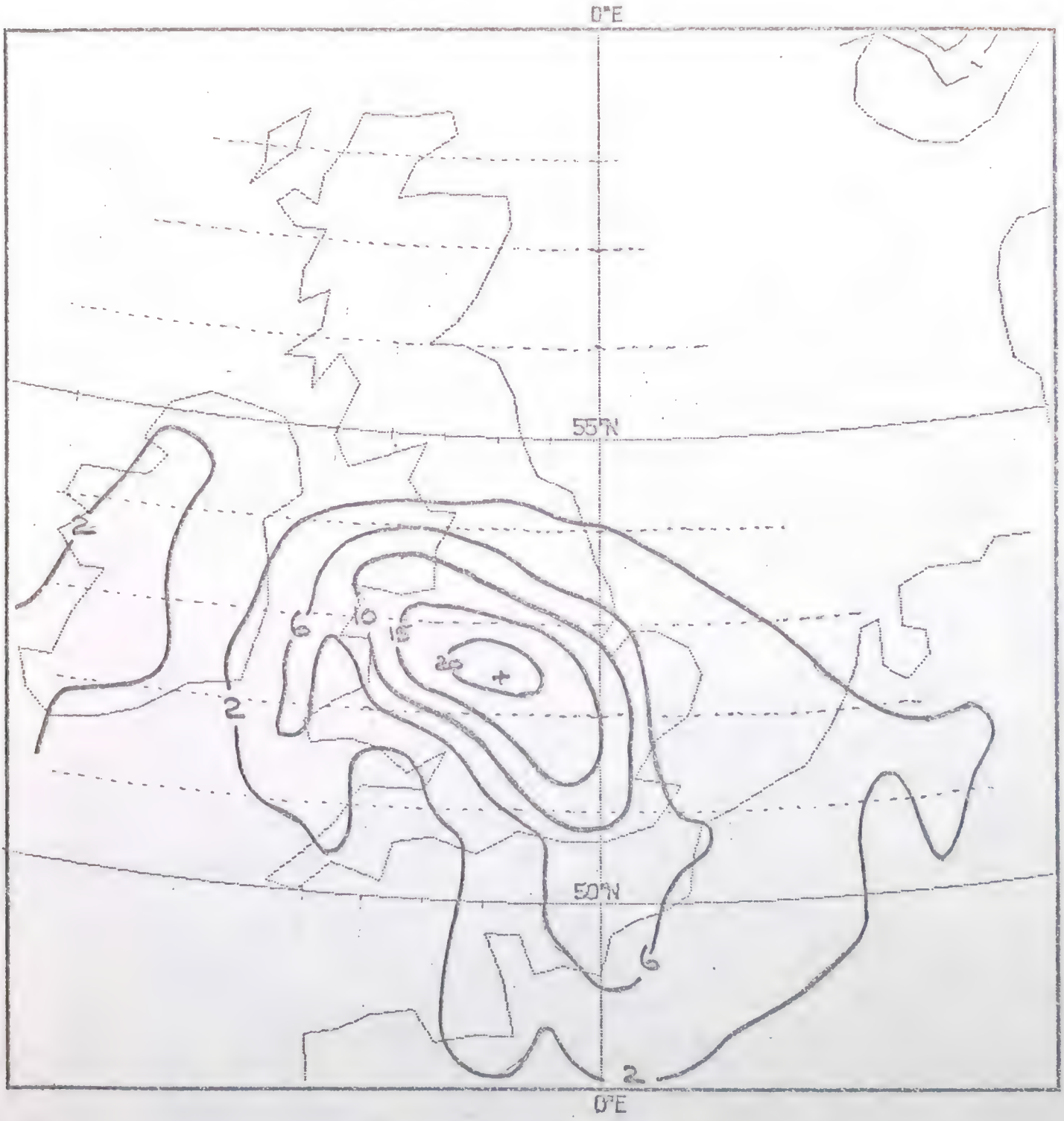
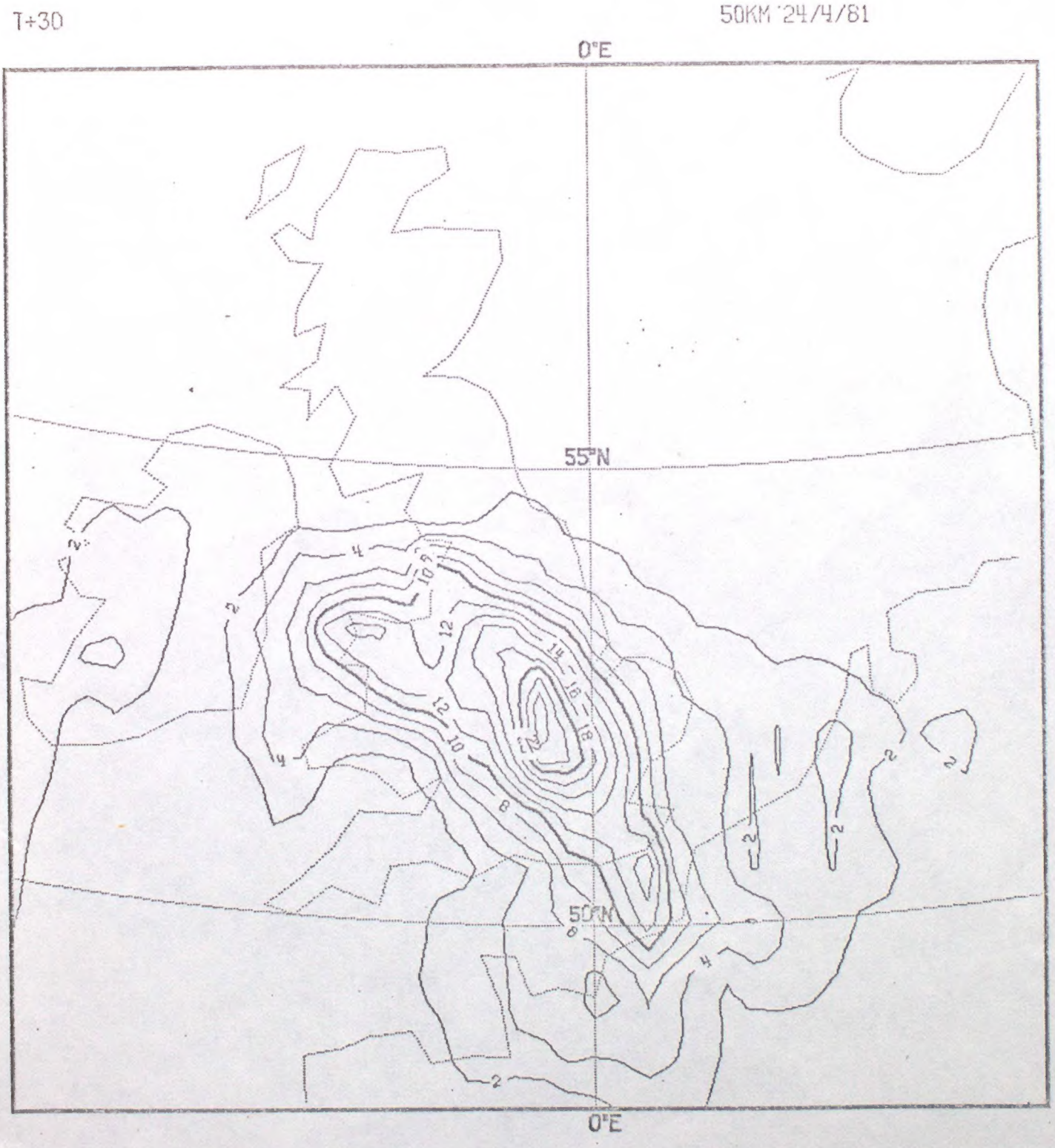
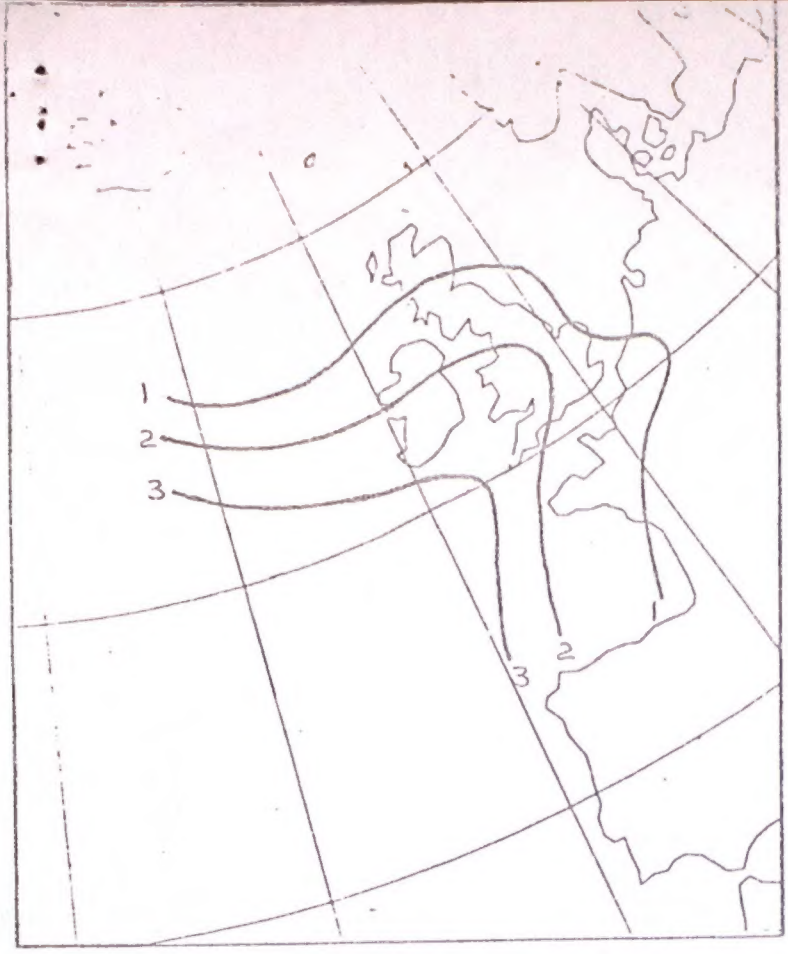


Fig. 22 New Model Fine Mesh (50km Grid) Forecast Accumulated Rainfall 1800Z 24 April 1981 to 0600Z 25 April 1981.

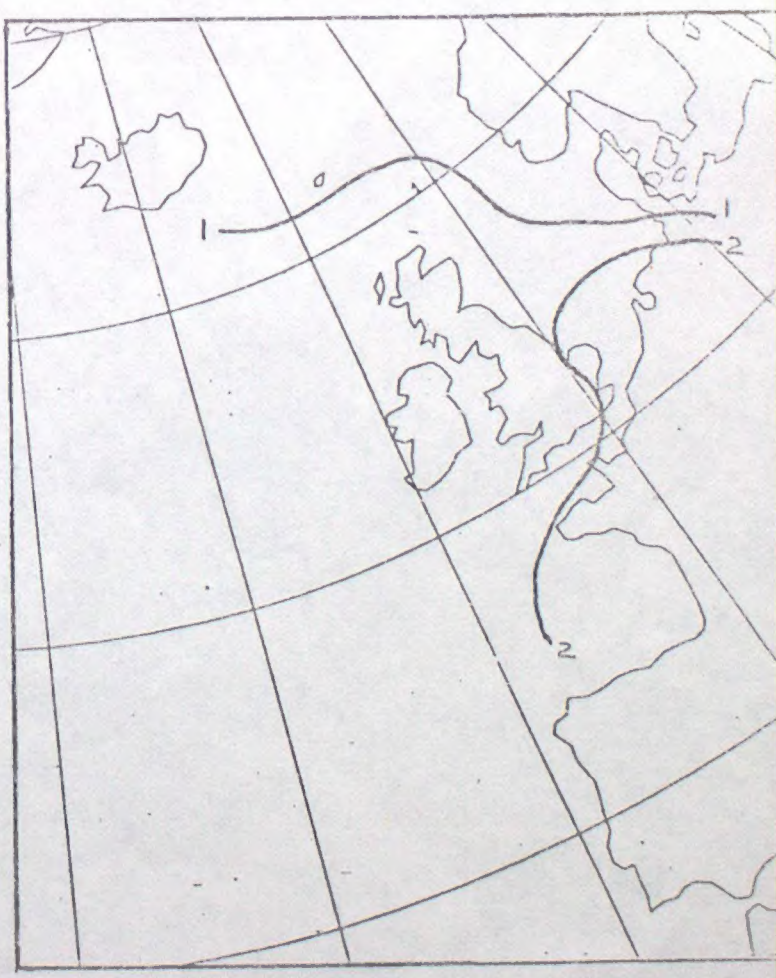




24 APRIL 81 DT 00Z 750MB HMR.

Fig. 23 ACTUAL 750mb HMR ANALYSES.

25 APRIL 81 DT 00Z 750MB HMR



25 APRIL 81 DT 12Z 750MB HMR

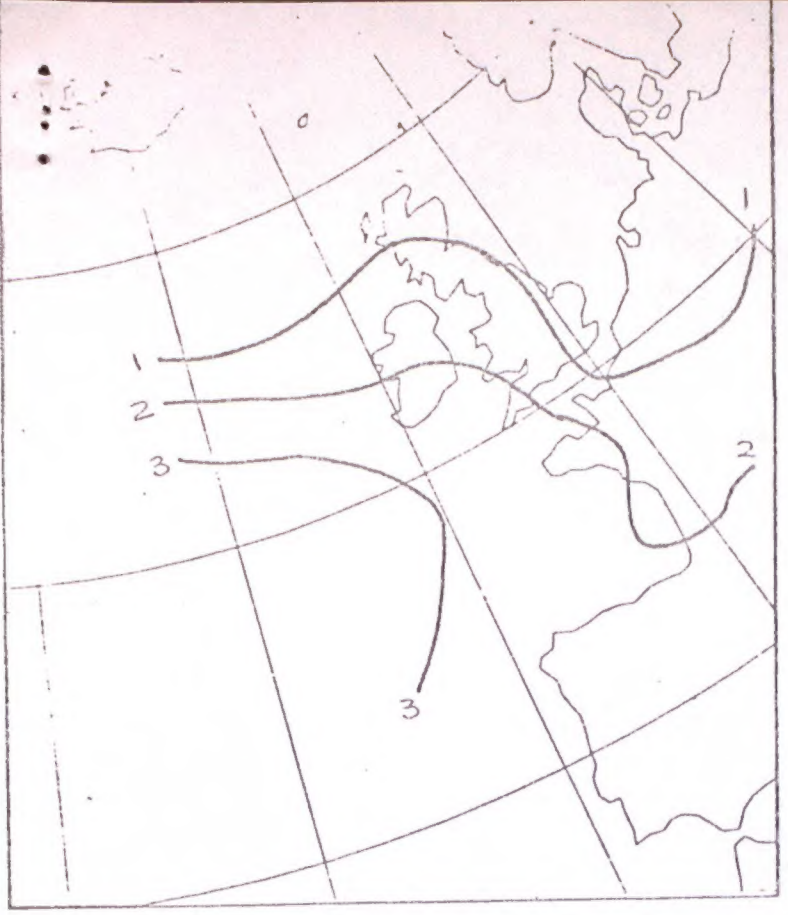
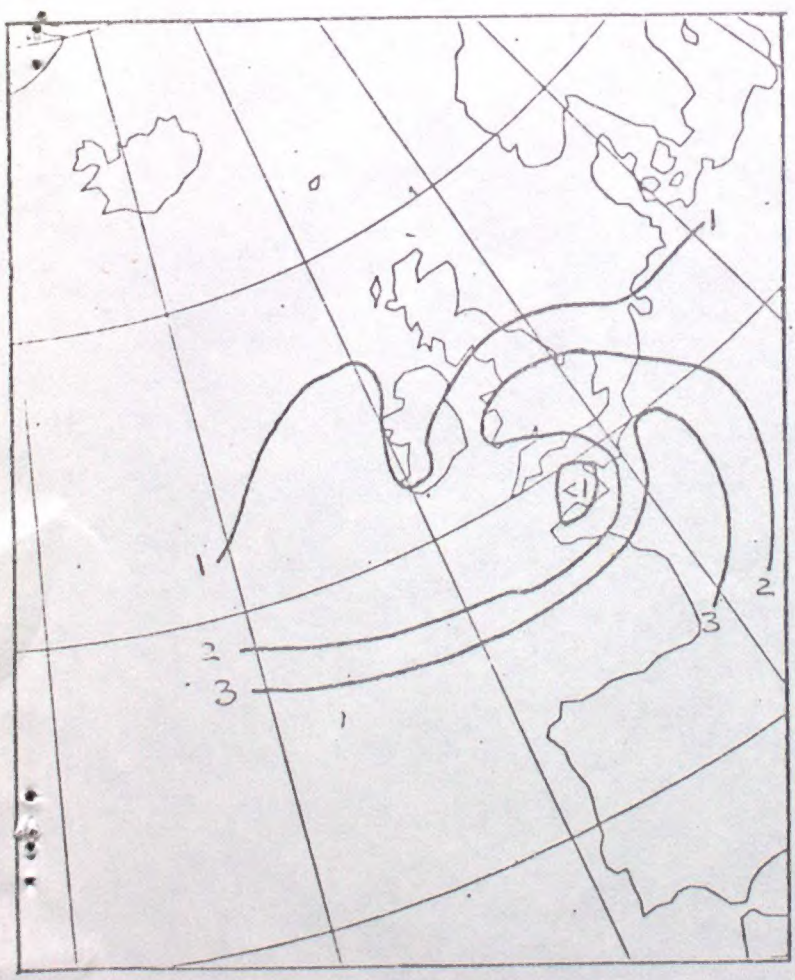
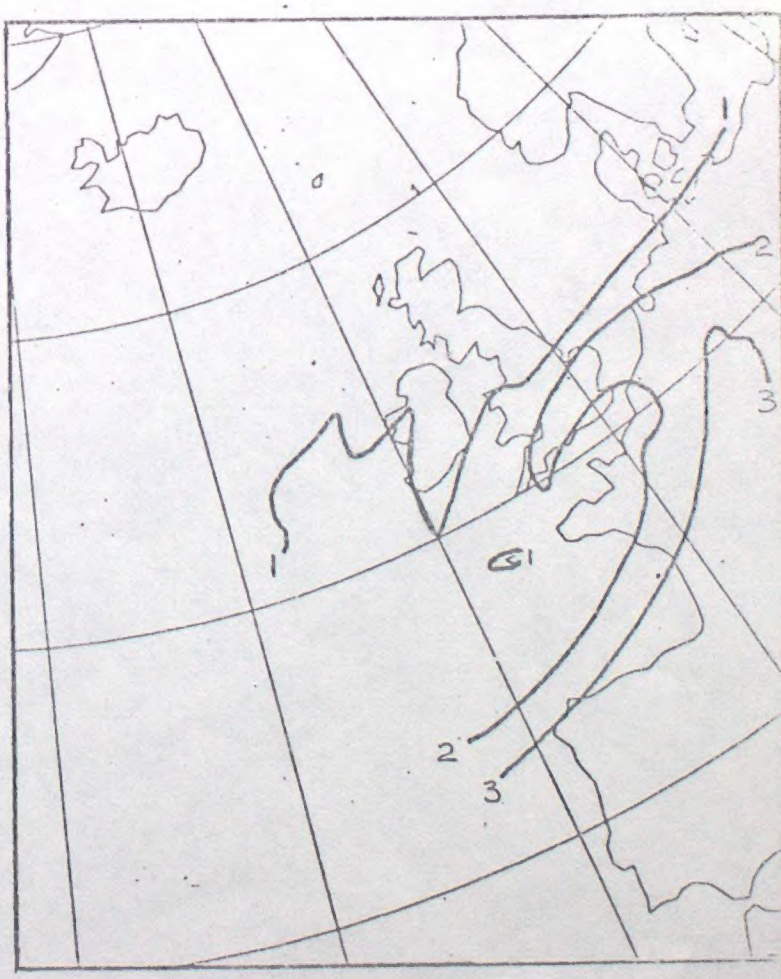


Fig. 24 Rectangle 750mb HMR

24 APRIL 81 RECTANGLE T+0 750mb HMR.
00 Z VT.



25 APRIL 81 RECTANGLE T+24 750mb HMR.
00Z VT.



25 APRIL 81 RECTANGLE T+36 750mb HMR
12Z VT.

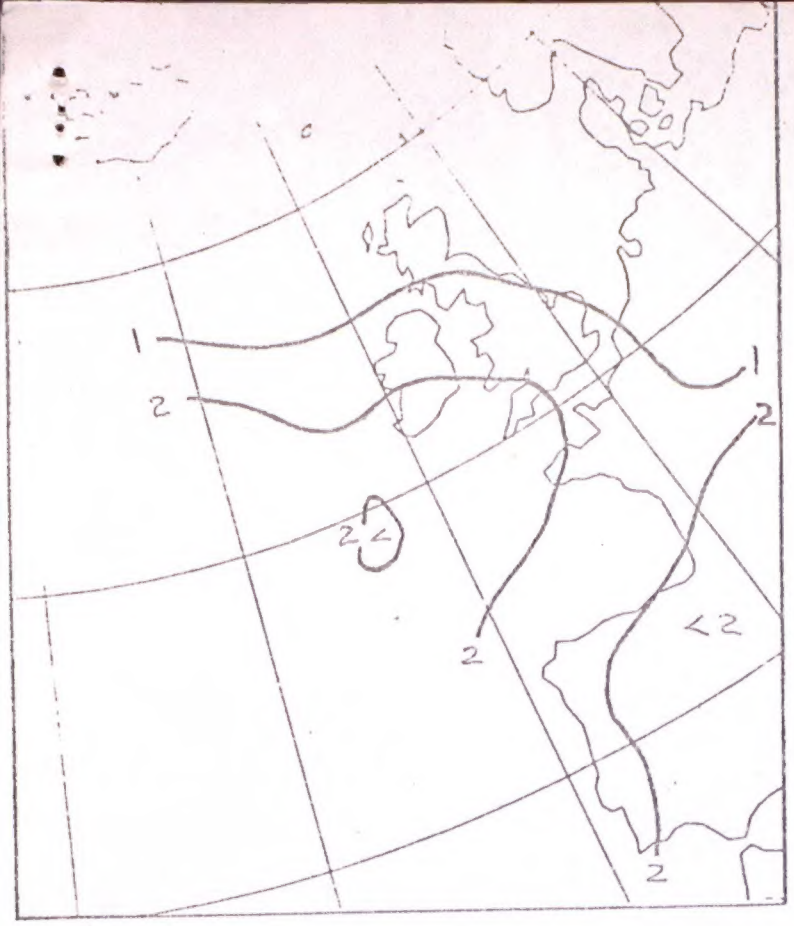
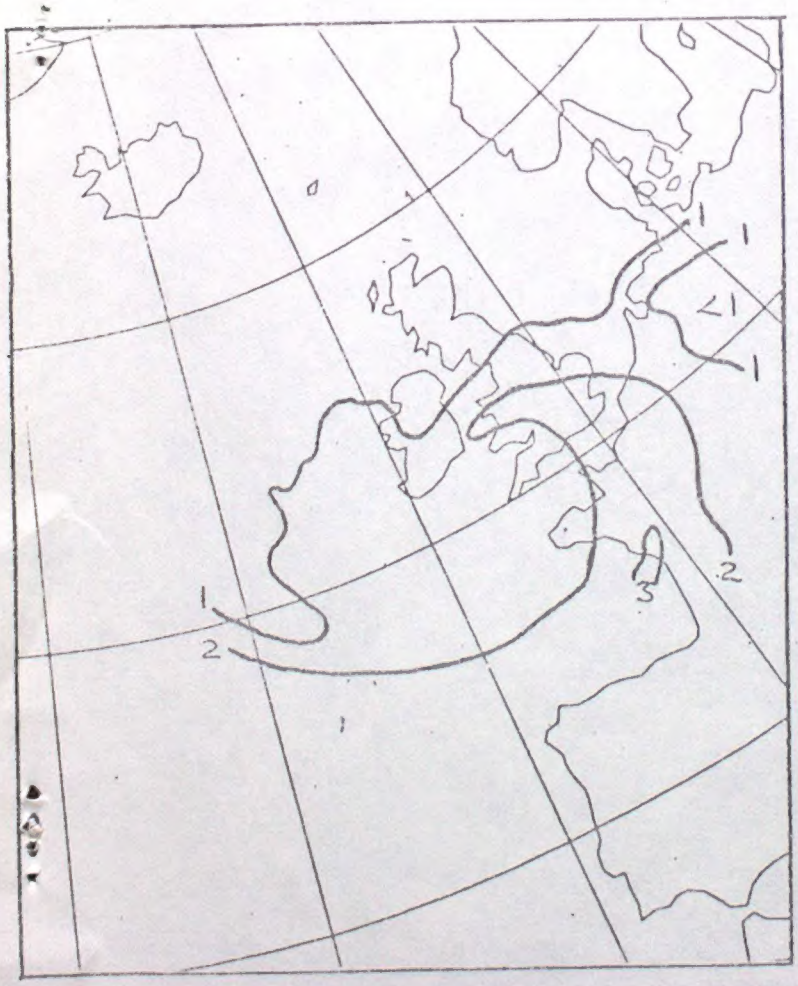


Fig. 25 New Model Fine Mesh (75km Grid) 750mb HMR.

24 APRIL 81 FINE MESH T+0 750MB HMR
00Z VT (75KM GRID)



25 APRIL 81 FINE MESH T+24 750MB HMR
12Z VT (75KM GRID)

25 APRIL 81 FINE MESH T+36 750MB HMR
12Z VT (75KM GRID)